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Economic Analysis: Description and Methods

by
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Economic analysis (EA) is a key part of the resource allocation process for Military Construction (MILCON) and Commercially Financed Facilities (CFF) projects. Results of an EA provide valuable input in deciding which projects to fund for the most cost-effective use of tax dollars. This report provides Army installations with guidance for performing accurate EAs and reporting results properly. This information clarifies the Army policy on EA set by Army Regulation (AR) 11-28 and Office of Management and Budget (OMB) Circular A-104.

This report supersedes Technical Report P-151, *Economic Analysis: Description and Methods* (U.S. Army Construction Engineering Research Laboratory, 1983). The current report updates the previous information and addresses the role of ECONPACK in performing EAs. ECONPACK is a computer program that automates much of the EA process. It is available on the Programming, Administration, and Execution (PAX) system and in a personal computer version.

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Economic analysis (EA) is a key part of the resource allocation process for Military Construction (MILCON) and Commercially Financed Facilities (CFF) projects. Results of an EA provide valuable input in deciding which projects to fund for the most cost-effective use of tax dollars. This report provides Army installations with guidance for performing accurate EAs and reporting results properly. This information clarifies the Army policy on EA set by Army Regulation (AR) 11-28 and Office of Management and Budget (OMB) Circular A-104.

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performing EAs. ECONPACK is a computer program that automates much of the EA process. It is available on the Programming, Administration, and Execution (PAX) system and in a personal computer version.

FOREWORD

This work was conducted for the Directorate of Engineering and Construction, Headquarters, U.S. Army Corps of Engineers (HQUSACE), under the reimbursable task "Responsiveness Analysis for Military Programs." The HQUSACE Technical Monitor was Jill D. McLean, CEEC-PESO.

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ECONOMIC ANALYSIS: DESCRIPTION AND METHODS

1 INTRODUCTION

1-1. Background

a. With only a limited part of the U. S. defense budget available for military construction (MILCON), competition is intense among Army elements attempting to fund new construction, maintenance, and repair for their organizations. The need for these funds must be documented clearly following regulations. A key part of the project justification is the economic analysis (EA), which is mandated by Army Regulation (AR) 11-28 and Office of Management and Budget (OMB) Circular A-104.*

b. The requirement for a project is normally identified by the user at the installation. This requirement is documented on a project justification form (DD Form 1391) and submitted to higher command levels for approval. Project justifications are reviewed at the Major Command (MACOM), Headquarters, U.S. Army Corps of Engineers (HQUSACE), Office of the Secretary of Defense (OSD), and Congressional levels (fig 1-1). Lack of a proper EA in support of projects can result in deferral or elimination of the projects from the MILCON program.

c. On the DD Form 1391, EA justification is to be documented in paragraphs D.4 (Consideration of Alternatives), D.11 (Economic Justification), and SRP 1 (Special Requirements Paragraph 1). See AR 415-15 for additional information on DD Form 1391 project submission.

d. The only cases in which an EA is not required for examining alternative ways to meet an Army requirement are--

(1) When the decision-maker in charge determines that the cost of performing an EA is too high compared with any benefits from such an analysis. It should be realized that all EAs do not require the same level of effort. For simple problems, the EA may require only an hour or two of research, but this effort will provide the basis for a better decision.

(2) When Department of Defense (DOD) instructions or directives prescribe equipment age or condition replacement criteria, labor and equipment tradeoff standards, or requirements computations.

(3) When proposed actions are directed specifically by statute, regulation, or a directive of higher authority that precludes a choice or tradeoff among options, including different ways to fund a program or project. If the proposed action is the result of an Army request that has been approved by Congress, rather than an action initiated or directed by Congress, this exception does not apply.

e. It is important to note that if an EA is not provided, reasons (1) through (3) above, as specified by AR 11-28, must be documented on the DD Form 1391 for the project.

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*References are listed in Appendix A.

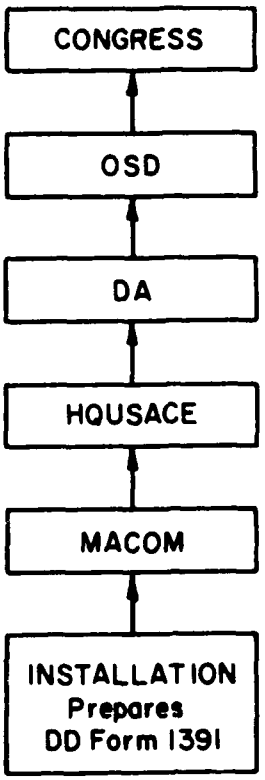


Figure 1-1. Project review process.

1-2. Objective

The objective of this work is to provide guidance to help installation analysts understand and develop economic analyses (EAs) in support of MILCON and Commercially Financed Facilities (CFF) projects and to report results in proper format.

1-3. Approach

a. This guidance was prepared using sound principles of engineering economics as applied to the unique MILCON environment.

b. This report provides complete enough information that a beginning analyst will be able to use it as a reference to perform simple EAs for the Military Construction, Army (MCA) program and CFF projects. (In this report, MCA is denoted by MILCON.) It describes the complete EA process and the analytical tools needed to perform EAs, as well as essential data and reporting requirements. It will be useful for all persons involved in EAs, from those who assist in providing data to those who make decisions using results of the EAs. Entry-level persons may need close supervision for their part in the analysis whereas journeymen and supervisors should be formally trained in EA.

c. All methods required to perform an EA for the MILCON process are provided in this report. It is self-contained in that the complete process of performing an EA is

described in detail with explanations of terminology,* equations, and reporting elements.

d. This report supersedes U. S. Army Construction Engineering Research Laboratory (USA-CERL) Technical Report P-151, *Economic Analysis: Description and Methods*, which was published in 1983. Information in this report updates that in the previous version and incorporates new developments in the field, including the role of ECONPACK in performing EAs. ECONPACK is a computer program that automates much of the EA process.

1-4. Scope

Although this report is directed toward the MILCON process, the basic EA procedures can be used for almost any EA.

1-5. Mode of technology transfer

Information in this report is being used to prepare a Department of the Army Pamphlet in the 415 series.

*Abbreviations and special terms used in this report are explained in the glossary.

2 CONCEPTS, GOALS, AND STEPS OF ECONOMIC ANALYSIS

2-1. Description of economic analysis

a. The Army never has adequate funding resources for obtaining facilities to meet new mission requirements, replace aging or functionally obsolete structures and renovate existing ones. Thus, decision-makers need economic evaluations to help them choose projects. They must be confident that the most economical and beneficial alternatives to meet Army needs are considered in the decision-making process. The best solution among many alternatives is identified and selected by doing an EA.

b. EA is a systematic method for studying problems of choice. Alternative ways to satisfy a goal (requirement) are studied by evaluating the quantifiable costs and benefits of each alternative. These costs are assessed objectively using economic and statistical techniques so that alternatives can be compared through a numerical ranking. The principle of life-cycle costing is used in EA (all resources required during the analysis period are considered).

c. EA is a commonsense approach for allocating scarce resources efficiently. The Army EA policy is simply a formal directive that describes EA processes.

d. An Army EA relies on three sound economic principles:

(1) All reasonable alternative methods of meeting an objective must be considered.

(2) Each alternative must be evaluated in terms of its total lifetime effects (life-cycle costs).

(3) The value of money changes over time. Adjustments must be made for this change so that the costs of alternatives can be compared at a common point in time.

e. An EA analyst uses a standard method to organize and present elements of an economic study so that--

(1) Informal thinking is focused and clarified.

(2) Hidden assumptions are found, discussed, and their impacts studied.

(3) Information is reported in simple, concise terms for use in recommendations and project funding decisions.

2-2. Goal of economic analysis

The goal of EA is to compare quantitative cost and benefit information for alternative solutions to a problem or requirement. Proper use of this information will lead to efficient allocation of scarce funding resources in the MILCON process. An EA is one of several decision criteria; it is *not* the only factor used by the decision-maker.

a. An EA promotes a clear understanding of the stated need, possible solutions, and cost implications. It allows the analyst to compare options on an equal basis (in time).

b. The EA approach results in an objective assessment of all costs, benefits, and uncertainties. Once identified, uncertainties can be evaluated through sensitivity analyses.

c. The ultimate goal is that tax dollars are spent most economically.

2-3. General guidelines for performing economic analysis

EA development consists of seven basic elements. An overview of these elements is given below. Chapter 3 contains a detailed discussion of each step.

a. State the purpose of the analysis clearly and concisely and, if possible, in quantitative terms. This is done so that a reviewer understands the project requirement to be met.

b. Develop a complete list of alternative solutions to the requirement. This list must be detailed or the validity of the EA may be questioned as it will appear to be biased.

c. Document any assumptions. The impact of assumptions can be tested later in sensitivity analyses.

d. Collect cost and benefit data. Sources of data and the data calculations must be documented as they are very important in determining accuracy.

e. Perform the EA calculations accurately. Nothing can cause a reviewer to return an EA more quickly than to find mathematical errors. Most errors can be avoided by using one of the standard computer programs (see para 2-8 below).

f. Test uncertainties in cost or benefit data--their values or the times they occur--to determine their impact on the results of the EA. Sensitivity analyses must be performed when large uncertainties exist.

g. Report the EA results. This is essential to show management and decision-makers that the best alternative has been selected and recommended for funding.

2-4. Guidelines for ranking alternatives

For most EAs, the best alternative is the one that is least cost to the Government over the period of time for which the requirement is to be met. The appropriate ranking method for a specific type of EA must be used. Specific techniques for ranking alternatives are given in Chapter 4.

2-5. Determining the scope of an economic analysis

The scope (alternatives considered) of an EA is defined in terms of the requirement, time period for the analysis, and the effort needed to perform it.

a. The scope of an EA will depend on the requirement being addressed. Normally alternatives considered will be confined to the installation/community and the immediate surrounding area. Space to house the installation commanding officer would be sited on

the installation. However, facilities to house visiting officers could be provided in the adjacent community. Alternatives may be limited by the mission requirement. For example, vehicle maintenance may be limited to on-post options for security reasons.

b. The scope of the EA in terms of time will usually be well defined in the statement of the requirement. For example, the number of years a central heating plant is needed would be stated in the requirement or would be understood to be the length of time that the installation would be active.

c. The scope in terms of level of effort required depends on the project. Not all EAs require the same level of effort. For example, if a range improvement costs $2M with annual outyear costs of $100K and the only alternative is to send troops to another base for training at an annual cost of $7M, no further data research is warranted. In this case, little effort will be spent developing the costs used in the EA. However, a complete life cycle comparison must still be done.

2-6. Applicability of economic analysis techniques and processes

a. EA can be applied to all decisions for which there are at least two possible ways of meeting a requirement. The EA provides the decision-maker with the relative ranking of options with respect to cost over the life of the project.

b. EA can be applied to very small problems such as replacing versus leasing a duplicating machine as well as very large ones such as base consolidations.

c. EA is an indispensable tool to management in planning for the future. In the normal funding environment, the Army never has enough funds to complete all its goals. EA can assist management in allocating these scarce funding resources in the most efficient way.

2-7. Guidance for overseas commands and installations

Overseas commands and installations face several issues different from those in the continental United States (CONUS).

a. The options may be very limited due to host country restrictions, and U.S. laws may limit MILCON or leasing opportunities.

b. Exchange rates for foreign currencies fluctuate greatly and their future values are difficult to estimate.

c. Foreign inflation rates are much different than those in the United States.

2-8. Computer programs for EA

a. Proper preparation of an EA requires a major effort to gather data, do the mathematical calculations, and summarize results into required report formats. Use of currently available computer programs can reduce the time required, ensure correct calculations, and produce results that comply with DOD guidance.

b. The ECONPACK program is available on the MILCON Programming, Administration, and Execution (PAX) System. A microcomputer version (PC ECONPACK) is available that allows the computer input file to be uploaded to the mainframe system. Thus, an analyst can run EAs on a personal computer until a final result is achieved. The mainframe version allows automatic copying of the EA results into the DD Form 1391 which is required before the DD 1391 is submitted for higher level review. Information on these programs can be obtained from HQUSACE (CEEC-PESO).

3 PRINCIPLES OF ECONOMIC ANALYSIS

3-1. The economic analysis process

The seven steps in the EA process are shown in figure 3-1 and discussed in detail below.

a. Step 1: Establish the objective. The single most important step in an EA is to define the objective. Without a clear, concise statement of what the EA is to evaluate, the EA will not be successful. With this definition, the analyst sets the objectivity of the analysis. An improperly stated objective may indicate that the EA was done to justify a conclusion and not to determine--without bias--the most economical solution for a requirement.

(1) Consider the following two objectives:

(a) Provide 35,000 sq ft of general warehouse space for a 15-year period.

(b) Construct a general warehouse building with an area of 35,000 square feet with a 15-year life.

(2) The first states an objective in unbiased terms whereas the second is biased toward constructing a new facility. The *wording* is critical in stating the objective. Not only should it be unbiased, but it should also contain explicit criteria for measuring the results from the proposed concept. In the above, the goal is to provide 35,000 square feet of warehouse space for 15 years and any proposed solution must meet this criterion.

b. Step 2: Identify alternatives. The next step is to list possible alternatives for meeting the objective. Alternatives that are not feasible must be explained in the documentation but need not be included in the cost comparison. It is *vital* that all realistic options be considered and *documented* for higher levels of review. Common alternatives for requirements in the MILCON program are--

(1) New construction.

(2) Leasing.

(3) Renovation/conversion.

(4) Modification/addition.

(5) Commercially financed.

(6) Status quo.

(7) Other DOD/Federal agency facilities.

(8) Contract for services.

c. Step 3: Formulate assumptions. In most EAs, the analysts must make some assumptions. Common assumptions include the estimated useful life of an asset, an

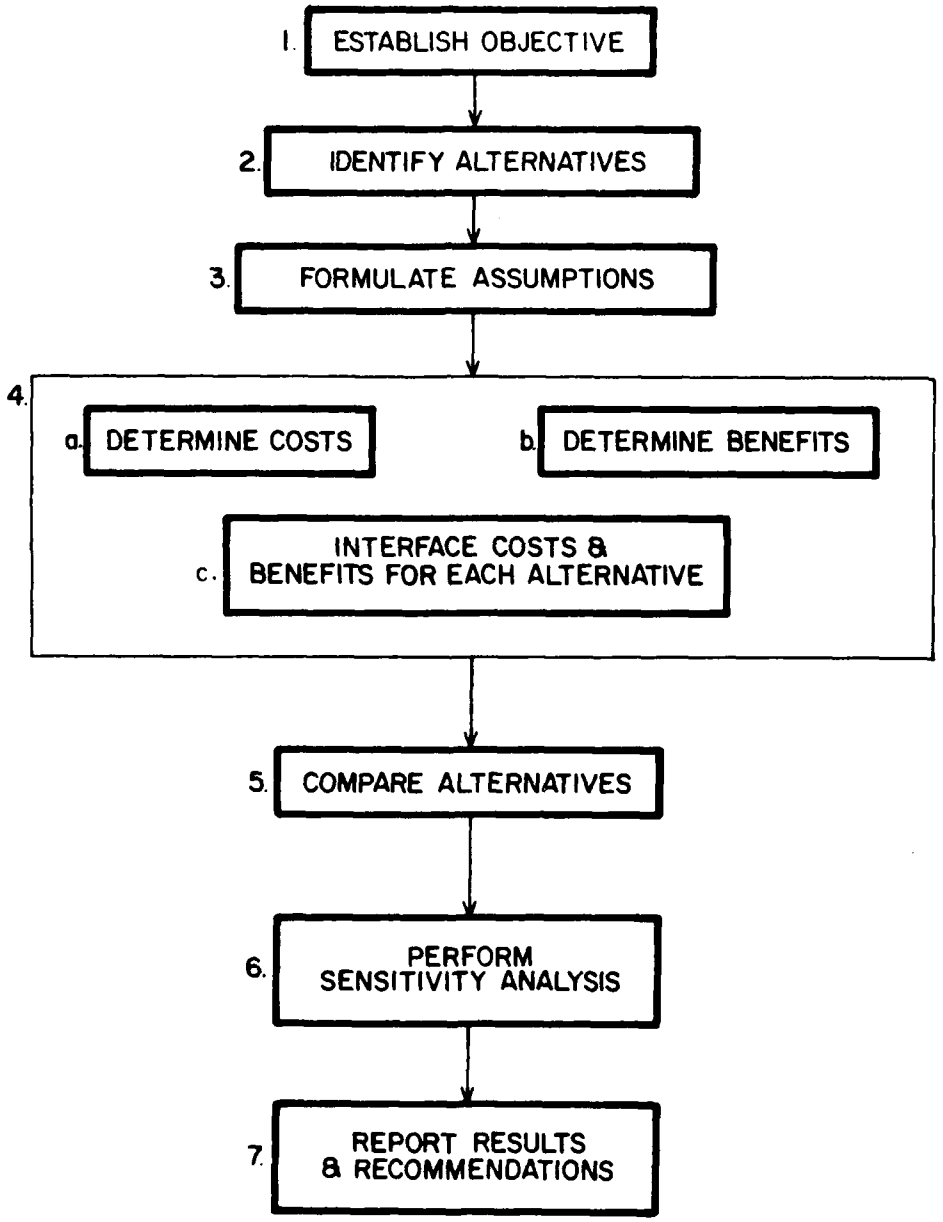


Figure 3-1. Steps of an economic analysis.

estimated requirement, the replacement time for a building component such as a roof, and the future cost of a required repair action. Often, analysts must formulate assumptions before they can choose alternatives wisely. Assumptions must be stated so that reviewers can assess their impact on the EA. Assumptions should never be used if factual data is available or can be obtained, as they can impact the validity of the analysis.

d. Step 4: Estimate costs and benefits. This step is the most difficult and time-consuming part of an analysis. The analyst must consider all costs and benefits associated with each alternative and how to collect or estimate them. They must be determined for the entire life of the project to reflect total life-cycle costs. Estimates must be made for the year in which the cost is to be incurred or the benefit is to be received. Each option must be studied separately. This step is critical as the overall accuracy of the EA depends on the accuracies of these estimates. Meaningful conclusions can only be obtained from meaningful data.

e. Step 5: Compare costs/benefits and rank alternatives. This step is the heart of the analysis. It is also the easiest, because once the first four steps have been completed, the comparisons and ranking can be done using computer programs. Comparisons give managers the information needed to make informed decisions. Once the costs and benefits for all options are found, one option can be compared with another. The main benefit to be derived from a MILCON project is fulfillment of the stated objective. This is a benefit common to all feasible alternatives, and its inclusion in the EA calculations would not affect the ranking of the alternatives. Thus, dollar quantification of the major benefit is unnecessary. Emphasis is, therefore, placed on the costs of the alternatives. Dollar quantifiable benefits (other than meeting the stated objective) of each alternative are treated as cost offsets for that alternative.

(1) Three general criteria are used to compare and rank them:

(a) Least cost for a given level of effectiveness.

(b) Highest effectiveness for equivalent cost, or--

(c) The largest ratio of effectiveness to cost.

(2) These three criteria conform to the three basic types of cost/benefit relationships:

(a) Unequal cost/equal effectiveness.

(b) Equal cost/unequal effectiveness.

(c) Unequal cost/unequal effectiveness.

(3) At times, alternatives have equal costs and equal benefits. When this happens, an alternative is chosen based on noneconomic factors. In most MILCON EAs, the first type is applicable--all alternatives would have the same effectiveness such as providing quarters for 100 officers, and the lowest cost option is the one preferred. Table 3-1 shows how to compare the alternative.

f. Step 6: Perform sensitivity analysis. A sensitivity analysis is a "what-if" exercise. It tests whether the conclusion of an EA will change if some variable such as a cost, benefit, or assumed inflation rate changes.

Table 3-1. Comparison of alternatives

Costs	Benefits	Basis for Recommendation
Equal	Unequal	Most benefits
Unequal	Equal	Least costs
Unequal	Unequal	Highest benefit-to-cost ratio
Equal	Equal	Other factors

(1) Sensitivity analyses should always be performed when--

(a) The results of the EA do not clearly favor any one alternative, or--

(b) There is a great deal of uncertainty about a cost, benefit, or assumption in the EA.

(2) If a change in a variable or assumption causes a change in the ranking of alternatives, the EA is said to be "sensitive" to that variable or assumption. By performing a sensitivity analysis and including its results in the report, the analyst assures the decision-maker that uncertainties in the EA have been tested and the results documented.

g. Step 7: Report results and recommendations. The EA report should be detailed and include data sources. It is important to state the recommendation because the cost comparison alone may not determine which alternative best meets the objective. A detailed outline for reporting is given in chapter 8.

3-2. Classes of economic analyses

There are two types of economic analyses: secondary and primary. A secondary analysis is for a situation in which a new requirement is to be met or when the current method of meeting a requirement is no longer suitable to meet that requirement. A primary analysis is performed when a better, *less costly* way to meet an existing requirement is proposed; that is, although the requirement is being met by the current method, a better method is available.

a. Secondary analysis. In a secondary economic analysis, the most economical option is selected from a group of options, all of which will perform a function or satisfy a mission which is not justified on the basis of dollar savings. For example, an additional facility requirement may be justified due to the expanded mission of an installation. The economically preferred alternative does not result in an absolute savings; rather it represents the least-cost alternative relative to other possible alternatives. Examples are a requirement to house 1,000 more trainees, a requirement to maintain an extra 100 tanks, and the need to provide a facility to meet current demands of the users.

b. Primary analysis. In this type of analysis, the purpose of assessing alternatives to a present method of operation for meeting a requirement is to minimize costs to the Government. Investments supported by primary EAs must predict absolute cost savings over the present method of meeting the requirement. An example is constructing a new automated maintenance facility to increase productivity.

c. Results of these two types of analyses have different impacts on the Army's cash flow. Secondary EAs justify investments that start an expense stream. Primary EAs justify investments intended to reduce an existing cash flow.

3-3. Present value and discounting

EA alternatives are compared and ranked using present values of costs/benefits. The concept of time value of money is fundamental to EA and must be understood before other aspects of the analysis can be discussed. The value of $1,000 today is not the same as $1,000 5 years from now. Money is a productive commodity and there is a price for its use. This price is called interest. Interest is expressed as a percent or decimal representing the fractional amount of a loan the borrower must pay the lender within a specified interval of time.

a. Compound interest. Suppose an amount of money P is borrowed today at an annual interest rate i. The amount of money, P, is called the principal. Assume that the money is to be repaid at the end of 1 year. At that time, the borrower will have to pay the lender not only the principal, P, but an additional amount, P x i. This surcharge, Pi, is the price (interest) the borrower must pay for the use of the money for the year that the loan is outstanding. The total future amount F_1 paid to the lender is thus--

$$F_1 = P + Pi = P(1 + i) \qquad \text{(eq 3-1)}$$

(1) Now suppose the above loan is to be repaid at the end of 2 years instead of 1 year. The amount which would have been repaid at the end of year 1 is P(1 + i), as shown in equation 3-1. This becomes the principal during the second year; that is, the interest has been compounded at the end of year 1. The amount repaid at the end of year 2 is--

$$F_2 = P(1 + i) + [P(1 + i)]i$$

$$= P(1 + i)(1 + i) = P(1 + i)^2 \qquad \text{(eq 3-2)}$$

(2) In equation 3-2, P(1 + i) takes the place of P in equation 3-1. An example of computing compound interest is shown in figure 3-2. To compute compound interest for n years, the same reasoning is used. The general equation for the total amount to be repaid to a lender at the end of n years for an amount P loaned today at an annual rate of interest i is:

$$F_n = P(1 + i)^n \qquad \text{(eq 3-3)}$$

Problem: A savings account is opened at a bank with an initial deposit of $10,000. If the bank pays interest on savings at the rate of 10 percent per year, what will be the balance after 3 years? (Assume no deposits or withdrawals in the 3 years.)

Solution: This is the same as a loan by you to the bank. Here P = $10,000, i = 0.10 and by equation 3-3--

$$F_3 = \$10,000(1 + 0.10)(1 + 0.10)(1 + 0.10)$$

$$= \$10,000(1.10)^3$$

$$= \$10,000(1.331)$$

$$= \$13,331$$

Figure 3-2. Example of computing compound interest.

(3) Another way of viewing this loan is that the future value to the lender of P dollars today is $P(1 + i)^n$ dollars n years from today. The borrower, in order to secure P dollars today, is willing to pay $P(1 + i)^n$ dollars n years from today. The lender and borrower complement each other as P dollars today and $P(1 + i)^n$ dollars n years from now are equivalent. Using equation 3-3, any principal amount can be converted to a future value. The reverse is also true. Rearranging the equation, any future amount can be converted to its present value. If the principal, P, in equation 3-3 is viewed as the present value (PV) of the future amount F_n, the relationship can be expressed as--

$$PV = F_n \frac{1}{(1 + i)^n} \qquad \text{(eq 3-4)}$$

(4) In equation 3-4, F_n represents the dollar amount value n years in the future of an investment today at an interest rate i. The PV represents a cash equivalent in today's dollars (that is, a present value or present worth). The quantity $1/(1 + i)^n$, which is a number less than unity, reduces the future cash amount, F_n, to its equivalent PV, and is called a *discount factor*. Figures 3-3 and 3-4 show examples of computing the present value rather than the future value.

b. The Army is no different from a private investor in that it seeks the best return on its investments. Thus, in Army economic analyses, future costs and benefits are brought to a common point in time so that valid comparions can be made.

(1) In equation 3-4 the value of i is called the *discount rate*. This rate is established by the Office of Management and Budget (OMB). The rate depends on the problem being analyzed. A rate of 10 percent is specified for most MILCON-type problems. For analyses with a *lease* as an alternative, the rate is the same as the interest rate for new issues of U.S. Treasury securities of the same term, in years, as the project life being analyzed.

Problem: A parent wishes to establish a college account for a newborn child. The parent estimates the education will cost $40,000 18 years from now. If the interest rate on the account is guaranteed at 8 percent indefinitely, how much must be invested today to have $40,000 on the child's 18th birthday?

Solution:

Here, F_n = $40,000, i = 0.08, and n = 18.

The formula is--

$$PV = F_n \frac{1}{(1+i)^n}$$

$$PV = \$40,000 \frac{1}{(1.08)^{18}} = \$40,000(0.2502)$$

$$= \$10,008$$

Figure 3-3. Example of computing present value for investment purposes.

Problem: An installation needs to reroof a large building. Roof material A will last 15 years and cost $2M to replace at that time. Material B will last 22 years with a replacement cost of $2.8M. An interest rate of 10 percent is used to compare the materials. Which is the least cost with respect to replacement cost?

Solution:

$$\text{Material A:} \quad PV = \frac{\$2M}{(1.10)^{15}} = \$2M\ (0.2394) = \$478,800$$

$$\text{Material B:} \quad PV = \frac{\$2.8M}{(1.10)^{22}} = \$2.8M(0.1228) = \$343,840$$

Material B is least cost. In today's dollars, its replacement cost is less than that of Material A.

Figure 3-4. Example of computing present value for a least-cost comparison.

(2) Figure 3-5 shows the difference between using and not using discounting in comparing three alternatives. Appendix B gives tables of discount factors for 10 percent, the most widely used rate in MILCON. Both end-of-year and mid-year rates are given. End-of-year means that the cost or benefit occurs at the end of a year whereas mid-year factors are used for costs/benefits occurring in the middle of the year. If they occur evenly during the year, it is customary to use the total for the year and use a mid-year factor. Equation 3-4 is used to calculate both end-of-year and mid-year factors. As an example, to calculate the end-of-year factor for 10 years, use 1 for F_n and 10 for the value of n; to calculate the mid-year factor for 10 years, use 9.5 for the value of n.

Projects A, B, and C each require equal investments, but the occurrence of costs varies by years as shown below.

Year	A	B	C
1	$7,500	$0	$5,000
2	7,500	0	12,000
3	7,500	0	16,000
4	7,500	0	3,000
5	7,500	37,500	1,500
Total (Nondiscounted)	$37,500	$37,500	$37,500

Alternative A:

Year	Cost ($)	10% Discount factor	Present value ($)
1	7,500	0.909	6,818
2	7,500	0.826	6,195
3	7,500	0.751	5,632
4	7,500	0.683	5,122
5	7,500	0.621	4,658
Total (Discounted)			28,425

Alternative B:

Year	Cost ($)	10% Discount factor	Present value ($)
1	0	-	-
2	0	-	-
3	0	-	-
4	0	-	-
5	37,500	0.621	23,288
Total (Discounted)			23,288

Alternative C:

Year	Cost ($)	10% Discount factor	Present value ($)
1	5,000	0.909	4,545
2	12,000	0.826	9,912
3	16,000	0.751	12,016
4	3,000	0.683	2,049
5	1,500	0.621	932
Total (Discounted)			29,454

Disregarding the time value of money, the alternatives are equal in cost. But, incorporating the time value of money and using a 10 percent discount rate shows that alternative B is preferable to either of the others.

Figure 3-5. Example showing impact of time value of money.

(3) There is a relationship between mid- and end-of-year discounting. A present value calculated using end-of-year discounting can be converted to mid-year by multiplying by $(1 + i)^{0.5}$ and, conversely, a present value computed using mid-year discounting can be converted to end-of-year by *dividing* by $(1 + i)^{0.5}$.

(4) Each table has a column of single-year present worth factors to be used for cost(s) in one year. Each also has a column of cumulative factors for use when the cost(s) occurs in every year. For example, to discount a $10,000 cost occurring in years 1, 2, and 3 (end-of-year), use table B-1. The present value can be calculated by either--

$$\$10,000(0.909) + \$10,000(0.826) + \$10,000(0.751) = \$24,860$$

or--

$$\$10,000(2.487) = \$24,870$$

(The $10 difference is due to rounding.)

c. Summary. Money is a productive commodity and as such commands a premium, called interest, for its use. Because of this, there is a time value associated with money. A dollar today is worth more than a dollar 5 or 10 years from now. (A dollar today can be invested and earn interest.) Investors take this fact into account when analyzing an investment proposal involving expenditures and receipts at varying points in time. To make meaningful comparisons, costs and returns must be converted into equivalent costs and returns occurring at a single point in time. This point is usually the present or the time of analysis. Equation 3-4 is used to convert future values to that time.

3-4. Economic analysis period

The economic analysis period begins with the year to which costs are discounted. Figure 3-6 shows the relationships between key dates in a typical analysis period for a construction project in the MILCON program. These key dates are defined below.

a. Base year of an economic analysis is the year to which all costs and benefits will be discounted. This year can be either before, after, or the same year that costs/benefits begin to occur for any alternative. Normally, the base year will be the year in which the EA is performed or the same year as the start year (defined below). From a purely mathematical viewpoint, the choice of a base year will not affect the rankings of alternatives, only the magnitude of difference between them.

b. Start year is the first year in which initial investments are made (first year in which costs occur) and often is the first year of the period of analysis.

c. Lead time is the time from the beginning of the start year to the beginning of the economic life of the asset. There may be a significant lead time between the initial investment expenditure and the beginning of the economic life of the asset. Economic life of an asset starts only when the Army begins to receive tangible benefits. Usually this is the date of beneficial occupancy of a facility.

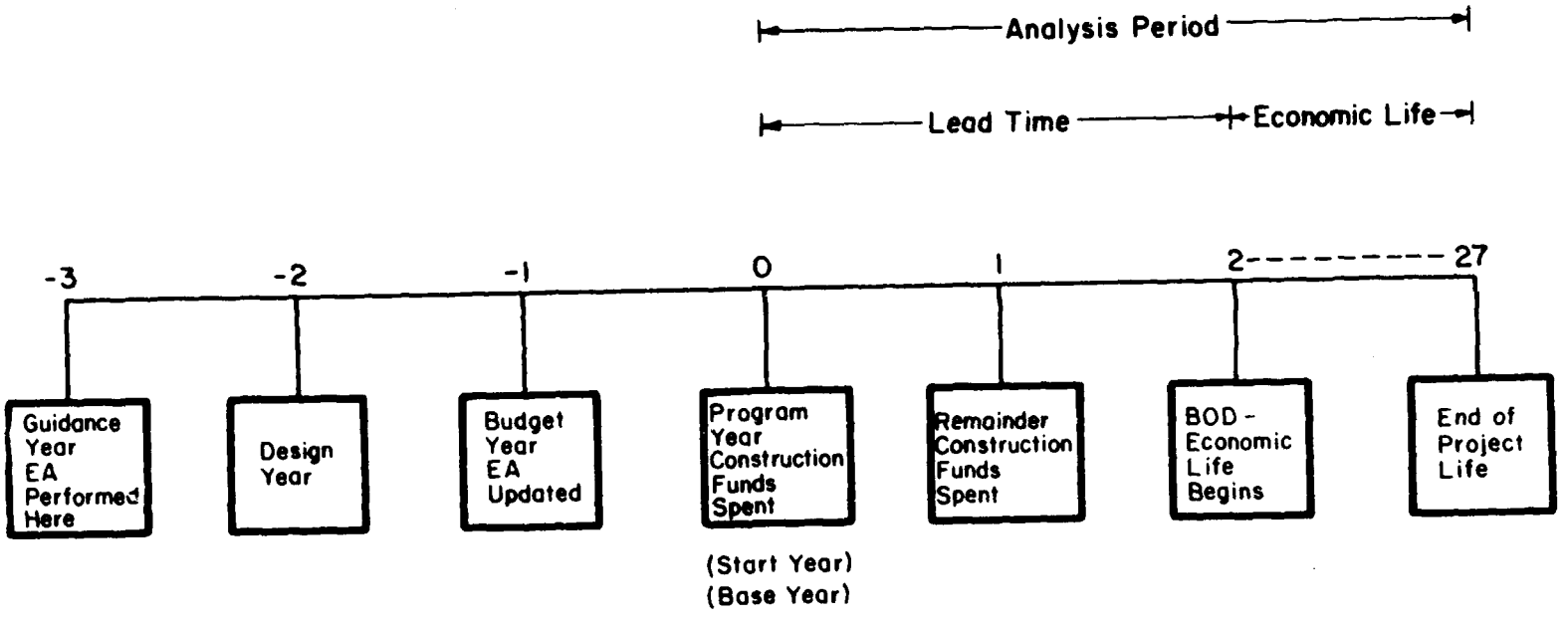


Figure 3-6. Relationships among key dates in an analysis period for a typical MILCON project. EA preparation usually is in the first part of the guidance year. (See AR 415-15 for more details on the design and budget process.)

d. Analysis period is normally the time from the start year to the end of the mission requirement (period of time over which comparisons are made). The mission requirement may be indefinite, but in MILCON EAs, long-range planning is usually 25 years.

e. Economic life of an asset is the period during which it provides a positive benefit to the Government.

(1) The economic life of an asset in an analysis is limited by--

(a) The mission life (period over which the asset is needed).

(b) The physical life (period over which the asset is expected to function).

(c) The technological life (period of technological usefulness).

(2) Usually, the economic life of an alternative will be the shortest of the three lives above. Table 3-2 gives guidelines for estimating economic lives. If shorter ones are used, reasons should be documented in the report. These guides can be interpreted as maximum lives. Local data or conditions may dictate shorter times to be used in the analysis.

Table 3-2. Economic life guidelines

Automated data processing (ADP) equipment	8 years
Buildings	
Permanent	25 years
Semipermanent, nonwood	25 years
Semipermanent, wood	20 years
Temporary or rehabilitated (with extra maintenance at 15 years)	25 years
Operating equipment	10 years
Utilities, plants and utility distribution systems (includes investment projects for electricity, water, gas, telephone, and similar utilities)	25 years
Energy-conserving assets	
Insulation, solar screens, heat recovery systems, and solar energy installations	25 years
Energy monitoring and control systems	15 years
Controls (e.g., thermostats, limit switches, automatic ignition devices, clocks, controls, photocells, flow controls, temperature sensors)	15 years
Refrigeration compressors	15 years

3-5. Developing cash-flow diagrams

a. One of the first steps in organizing cost/benefit data in an EA is to list, for each alternative, all costs, benefits and their timing. Often a cash-flow diagram is used to depict this information. A cash-flow diagram displays, in graphic form, the timing and magnitudes of all costs associated with a given alternative. Usually a diagram is drawn for each alternative in an analysis. Figure 3-7 is a cash-flow diagram for an alternative with a 10-year life, with an investment cost of $5000 at the beginning of year 1, mid-year annual costs of $300, one-time costs (mid-year) in years 4 and 8 of $500, and a salvage value of $2000. In a cash-flow diagram, costs are depicted with a downward arrow whereas benefits (such as savings) are shown as upward arrows.

b. It is important to place a cost at the proper point in time because its discounted value depends directly on the time it occurs. Once a cash-flow diagram is developed, the data can then be easily input into a computer program that will do the calculations.

3-6. Inflation

a. Inflation is a consistent rise in costs (prices) of goods and services over time. In EA, inflation is treated differently, depending on the project being analyzed. Three cases will be discussed: general MILCON projects with no inflation, (see c below) general MILCON projects with inflation on some cost elements (see d below), and projects with a lease as an alternative (see e below).

b. To discuss inflation concepts it is necessary to understand the concepts of *constant* and *current* dollars.

(1) Constant dollars indicate constant purchasing power, in terms of the dollar value in the base year of the EA. An EA is said to be in constant dollars if all costs are adjusted to reflect the level of prices for the base year. For example, if the annual maintenance cost is $20K in the base year, it will be $20K in each year of the analysis.

(2) Current dollars are expressed in the value of their year of occurrence. Past costs are simply expressed as the actual amounts paid out. Future costs are expressed in amounts expected to be paid in their year of occurrence. These costs include any amount due to inflation.

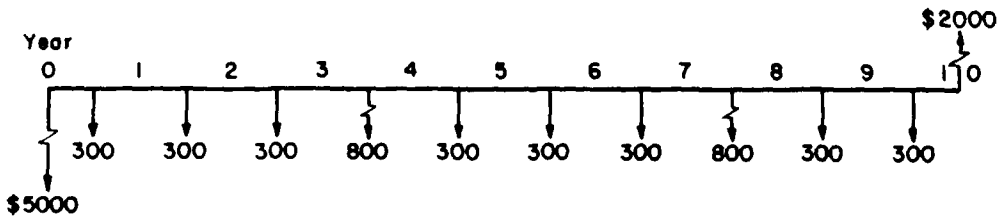


Figure 3-7. Example cash-flow diagram.

c. In the case of the typical MILCON project, inflation is not considered in the EA since the 10 percent discount rate specified by OMB Circular A-94 excludes the effect of any overall inflation. As documented in OMB Circular A-94, the rate of 10 percent represents an estimate of the average rate of return on private investment, before taxes and after inflation. Thus, in accordance with AR 11-28 for the general case, all costs are expressed in terms of constant dollars in the base year. For example, if the maintenance cost is $10,000 in the first year, it will have the same value for future years unless the maintenance workload increases.

d. In the case for which some costs are increasing faster than the overall rate of inflation, the value of those costs must be inflated before discounting is done. Suppose one of the costs is maintenance of a complex electronics station and the cost of labor is increasing 3 percent per year faster than the overall inflation rate. The cost at the beginning of the second year would be the cost at the start of the first year increased by 3 percent, the cost at the beginning of the third year would be the cost at the beginning of the second year increased by 3 percent (cost at end of third year = first year cost x 1.03 x 1.03 x 1.03, and so on). Once all inflated values are computed for this cost, they are discounted along with the other costs in the EA. Note: deflation is the opposite of inflation--a cost increase at a rate less than the general rise in prices. Deflation for a specific cost should be performed just as inflation is done.

e. OMB Circular A-104 requires that all costs be inflated when one of the alternatives in an EA is a lease. (Note that the interest rate on U.S. Securities used as the discount rate for these analyses does include inflation and thus *all* costs must be inflated.) It also suggests that a sensitivity analysis be done to evaluate the impact of changes in the inflation rate.

f. The best way to ensure that inflation is considered properly is to do the following steps:

(1) Determine all costs in terms of the base year dollar (constant dollars). This means that future costs may change only due to change in scope of work performed or goods purchased. For example, if the amount of maintenance on a building is expected to increase as it ages, then the yearly cost would be increased.

(2) When dealing with costs for which values are expected to change differently than the general rate of inflation, estimate this differential and apply it to the cost in the year(s) it occurs.

g. There is usually a time gap between the present (when the EA is performed) and the start year (when costs are first incurred). This means that costs estimated at the present time may have to be inflated to the start year. For example, if the analysis is done in 1990 and construction costs occur in 1993, these costs must be inflated from 1990 to 1993.

h. In most EAs, inflation will not be a problem. Only in those with lease as an alternative or with unusual costs (changing at a different rate than the general economy) must inflation be considered, except as noted in g above.

3-7. Life-cycle costing

EA helps the decision-maker allocate resources effectively only when all direct and indirect resource implications associated with each alternative are considered. The EA

must analyze the impact of all costs incurred during the lifespan of the project. This step is important because initial investment costs can be misleading. For example, renovation may require less of an initial capital investment, but its annual operations and major repair costs may be much higher than similar costs with other alternatives.

a. An investment decision commits many different resources for future allocation and various sources of funds. Construction of a maintenance shop, for example, involves not only the construction cost, but also--

(1) The allocation of land.

(2) The commitment of funds for personnel, operations, and routine maintenance.

(3) Other recurring and nonrecurring costs during the facility life.

(4) Possibly a cost to demolish the shop at a future point in time.

b. The goal of an EA is to give the decision-maker an essential piece of information for use in the resource allocation process. It gives an unbiased picture of the full life-cycle resource and benefit implications of each alternative. Once this information is available, a decision can be made to achieve the best level of national defense possible within the constraints of the Army budget.

3-8. Depreciation

The Government does not use depreciation as it has no impact on the cash flow. The only costs to be used in an EA for MILCON alternatives are for elements such as labor, materials, supplies and utilities.

a. In the private sector, depreciation write-off of a long-term asset is an accounting expense. The benefit is that a firm can deduct its depreciation allowance from net income before paying taxes.

b. In summary, depreciation write-off is used only when an income tax structure exists. It is irrelevant to the Government and therefore must not be included in analyzing Government investments. However, the concept of depreciation can be used to help estimate the residual value of an asset.

3-9. Economic analysis vs. budgeting

Economic analysis and budgeting are completely separate processes. EA is used to help determine the best alternative to meet an Army requirement. Data presented in the EA may or may not be useful in a future budget process. An EA may contain costs over several organizations, making it difficult to use them in the budgeting process for a single element. Some costs may be omitted from the EA because they are "wash" costs (the same for all alternatives). Also, the time basis of EA costs may differ from that of the budgeting process.

4 METHODS OF ECONOMIC ANALYSIS

4-1. General

This chapter describes five economic analysis methods used to compare alternatives. Each method includes examples of how and when to use it. One or a combination of these methods can be used for all EAs done for MILCON and CFF projects. Net present value or equivalent uniform annual cost must always be calculated, regardless of the type of analysis performed.

4-2. Net present value (NPV)

a. This method is used when all alternatives meet the mission requirement over the same period of analysis. This method is the "standard" way to compare alternatives in the MILCON process. It is the *only* method recognized by OMB Circular A-104 for EAs performed when one alternative is a lease.

b. NPV is calculated for each alternative. The alternatives are ranked and the one with the lowest NPV is the preferred option. The NPV is calculated for an alternative by discounting the value of the costs minus the benefits for each year and summing over the years for a total or net value.

c. Consider the two cash-flow diagrams in figure 4-1. The renovation alternative has an initial cost, annual maintenance costs, and a reroofing cost. The new construction alternative has a construction cost and an annual maintenance cost. It also has a large residual value. Figure 4-1 also shows the calculations needed to discount all costs and the residual value to the base year of the analysis--1990. Note that cumulative factors are used for a cost that occurs every year and single amount factors for a one-time cost.

(1) The NPVs calculated for each alternative are--

(a) New construction: $7,209,100.

(b) Renovation: $7,231,700.

(2) The difference of $22,600 shows that new construction is the most economical alternative. Because the NPVs are very close, further (sensitivity) analysis would normally be done and nonquantifiable factors considered before a recommendation could be made. This example shows that all life-cycle costs need to be considered: initial costs alone do not provide enough information to support a decision.

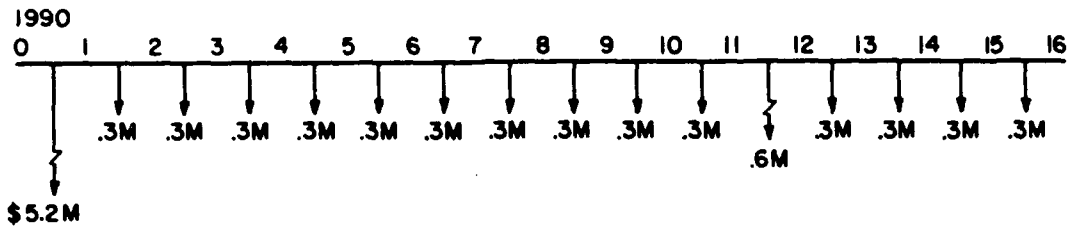
4-3. Savings/investment ratio (SIR)

EA finds the most economical way to meet a requirement, given that there is more than one alternative. As explained earlier, a secondary analysis addresses a requirement that is not adequately satisfied when the EA is performed. This is typical as most EAs in support of the MILCON program are secondary analyses. There is another possibility: a given requirement may already be met at the present time, but a *better* solution could be found. In the context of EA, "better" specifically means that the total NPV cost of an alternative is lower than that of the existing alternative (the status quo) over the same period (economic life). In such a case, the justification for implementing another alternative is economic; the analysis supporting the proposal is called a primary EA.

This example considers two alternatives: renovation and new construction. Either renovation or new construction would take place in 1990 and require 1 year to complete. There is a 15-year requirement. The analysis base year is 1990.

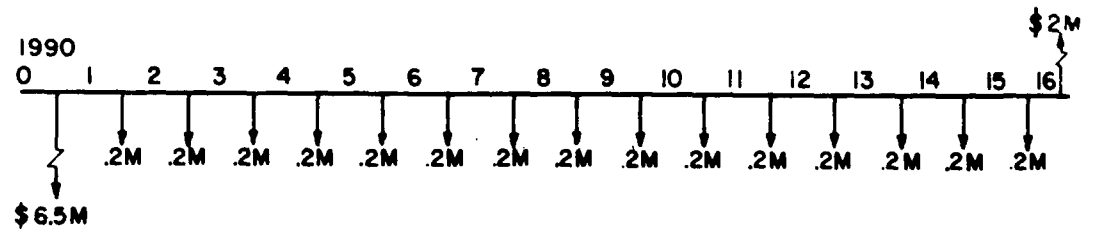
Renovation alternative:

Renovation cost of $5.2M, annual operation and maintenance (O&M) cost of $0.3M, and a reroofing cost of $0.3M in year 12 after BOD. All costs assumed to occur at mid-year. This alternative has no residual value.



New construction alternative:

Construction cost of $6.5M, annual O&M cost of $0.2M, and a residual value of $2M. Costs assumed to occur at mid-year; residual value at end-of-year 16.



Discount rate is 10 percent. All costs are discounted by mid-year except the residual value which is end-of-year.

$$NPV_{REN} = \$5.2M(0.953) + \$0.3M(8.206-0.953) + \$.3M(0.334)$$

$$= \$7,231,700$$

$$NPV_{NEW} = \$6.5M(0.953) + \$.2M(8.206-0.953) - \$2M(0.218)$$

$$= \$7,209,100$$

Using NPVs, the new construction is the more economical solution as its NPV is $22,600 (0.3 percent) less than that of the renovation alternative.

Figure 4-1. Example using NPV to rank alternatives.

a. In addition to comparing a proposed alternative with the status quo by examining the total NPV costs, another method is used for primary analyses--the savings/investment ratio (SIR). SIRs compare the profit potentials of the alternatives. SIR means exactly what it states--the ratio of savings resulting from an alternative (to the present method) to the investment required for implementing the new alternative. An SIR value of 1.0 means that the savings NPV equals the investment cost NPV required to effect those savings. Thus, for an investment to be economically feasible, the SIR must be greater than 1. If there are several alternative(s), their SIRs can be compared (ranked). However, the analyst must assess other implications of the analysis such as amount of the investment and the savings. For example, one alternative might have an SIR of 5.0 while another has an SIR of only 2.0. Normally, the one with the higher SIR would be preferred. But if the total savings over the analysis period for the option with the higher SIR is very small in total discounted dollars compared with the savings from the other option, the one with the smaller SIR may be preferred.

b. The SIR is used only to compare investment costs to savings to determine if the investment costs can be recovered through savings.

c. When computing an SIR, total annual maintenance and operations are not discounted--only the difference between annual costs for the two alternatives. Thus, the crucial question is: "Are the recurring savings of the alternative relative to the status quo large enough to justify the investment costs needed to implement the alternative".

(1) For an alternative A to a status quo Q, the total PV savings of A relative to Q can be calculated as--

$$PV(S) = PV(A_1-Q_1) + PV(A_2-Q_2) + \ldots + PV(A_n-Q_n) \qquad \text{(eq 4-1)}$$

where S is savings, PV is "present value of," and A_i and Q_i are yearly costs. Thus, the SIR is--

$$SIR = \frac{PV(S)}{I} \qquad \text{(eq 4-2)}$$

(2) If the investment extends over more than 1 year, it should also be discounted, so that the more general equation is--

$$SIR = \frac{PV(S)}{PV(I)} \qquad \text{(eq 4-3)}$$

d. Figure 4-2 shows an example of a primary analysis for existing and proposed methods of maintaining shelters.

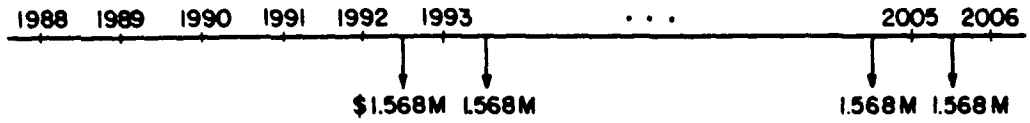
4-4. Discounted payback period (DPP)

An easily understood method of comparing alternative investments or for evaluating a single investment is "payback" analysis. Payback period is the time required for the total accumulated savings or benefits of a project to offset investment costs. Therefore, if a project cost $100 and yielded annual savings of $25, its undiscounted payback period would be 4 years. DPP is often used in conjunction with the SIR. If the SIR is greater than 1.0, indicating the project pays for itself, the question then becomes "How long does

Shelters are currently maintained in an open-air environment. It is proposed to construct an environmentally controlled maintenance facility to reduce operating costs.

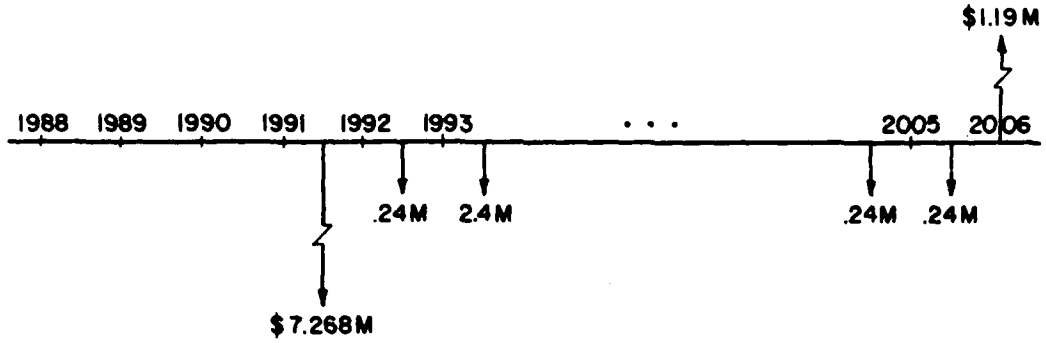
Status quo alternative:

The existing method requires an annual operating cost of $1.568M.



New facility alternative:

The proposed facility would cost $5.7M (1991 dollars) to construct, with an annual O&M cost of $0.24M and a residual value of $1.19M. The cost of using the existing method during the year of construction is also part of the cost of the proposed alternative (1.568M + 5.7M = $7.268M).



The analysis is performed in 1988 (base year); start year is 1991 and BOD is 1992. The requirement is for 15 years, so that the period of analysis is 19 years. A 10 percent discount rate is used, with mid-year convention for all costs except the residual, which uses end-of-year.

NPV(Savings) = ($1.568-$0.240)(8.773-3.325) = $7.235M

NPV(Investment) = $7.268M(0.716) - $1.19M(0.164) = $5.009M

SIR = $7.235M/$5.009M = 1.44

Figure 4-2. Example of a primary economic analysis.

To find the DPP, the cumulative NPV of investment is calculated for each year as well as the cumulative NPV of savings. The point at which they are equal is the DPP.

Year	Cumulative NPV Investment ($M)	Cumulative NPV Savings ($M)
1988	0	0
1989	0	0
1990	0	0
1991	0	0
1992	4.081	0.865
1993	4.081	1.651
1994	4.081	2.365
1995	4.081	3.014
1996	4.081	3.605
1997	4.081	4.142

Note that the NPV of investment is not reduced by the discounted value of the residual as that will not occur until 2006.

Calculate the exact DPP by--

$$9 + \frac{4.081 - 3.605}{4.142 - 3.605} = 9.89 \text{ years}$$

Then subtract 4 years--the savings will pay for the investment in 5.9 years after the savings begin to accrue.

Figure 4-2. (Cont'd).

it take to recoup the investment costs?" (A rule of thumb for an acceptable DPP is 10 years or less.) DPP, like SIR, is used with the NPV as an aid in selecting the best alternative.

a. The duration of project life has no effect on the payback period. For example, a payback period of 10 years has the same meaning whether the economic life is 15 or 25 years. Thus, the payback period can be used to help rank alternatives. Options with quick paybacks are generally preferred.

b. The time value of money must be considered in payback computations. Thus, all costs must be discounted to compute a DPP. Payback is achieved when the total accumulated PV savings are enough to offset the total PV costs of an alternative. The payback period is simply the total elapsed time between the point when savings begin to accrue and the point at which payback will occur. Figure 4-2 also shows DPP calculations.

c. A simple example is shown in figure 4-3. If an installation purchases a $5,000 machine, it can save $1,500 annually in operating costs. During its fifth year, the machine will need a $3,000 major overhaul. At the end of its 8-year life, the machine

will have no value. The total PV savings over the life cycle of the machine is $8,392. It is not until after year 6 that the cumulative PV(S) = PV(I). At that point, all discounted investment costs are recovered. The exact point of payback can be found through interpolation.

(1) First, compute the discounted (10 percent rate) dollar value of savings occurring in year 7: $6,953 - $6,851 = $102.

(2) Second, divide this amount by the total PV(S) for year 7 to find the proportion of that year during which the investment is being paid back: $102/$807 = 0.13.

(3) The result is a discounted payback of 6.1 years.

d. In the case for which annual savings remain constant throughout the entire analysis period, payback can be computed by using the cumulative discount factors in appendix B. Discounted payback for the example in figure 4-3 is computed by--

(1) Dividing the PV(I) by the annual savings--

$$\frac{\text{PV(I)}}{\text{Annual Savings}} = \frac{\$6,953}{\$1,500} = 4.635$$

(2) Compare this value with the cumulative discount factors in appendix B for a 10 percent discount rate. The corresponding year will be the point of payback. The value 4.635 falls between the discount factor for years 6 and 7. By interpolation, the exact point of payback is computed as 6.1 years.

e. Note: it is possible for the cumulative PV of savings to pay back the NPV of the investment and then for later investments to occur which show the PV of the savings to be less than the PV of investments. That is, the SIR may be greater than 1.0 for several years and then drop below 1.0 for a few years due to additional investments (replacement, renovation). The last time the SIR exceeds 1.0 is the correct DPP, and ECONPACK calculates this time.

NPV(investment) = $5,000 + $3,000(0.651) = $6,953

Year	Savings	Discount Factor	Cumulative PV(S)	Cumulative PV(S)
1	$1,500	0.953	$1,430	$1,430
2	1,500	0.867	1,300	2,730
3	1,500	0.788	1,182	3,912
4	1,500	0.716	1,074	4,986
5	1,500	0.651	977	5,963
6	1,500	0.592	888	6,851
7	1,500	0.538	807	7,658
8	1,500	0.489	734	8,392

Figure 4-3. PV cost savings.

4-5. *Equivalent uniform annual cost (EUAC)*

Methods considered so far have assumed that all alternatives in an EA have equal lives or lives greater than the period of analysis. However, it is not unusual for the lives of alternatives to differ. When this occurs, all of the alternatives must be compared on a common basis of time in order to make valid comparisons. The EUAC method allows the analyst to make this comparison.

a. The EUAC is an approach for evaluating alternatives with *unequal* economic lives that are less than the minimum requirement time period. It places all life-cycle costs and benefits for each alternative in terms of an average annual expenditure. Assuming that the alternatives are equally effective over their lives, the one with the lowest EUAC is the most economical choice.

b. Figure 4-4 shows a simple example.

(1) In the figure, it is assumed that--

(a) Each alternative satisfies the requirement.

(b) No end is seen to the requirement.

(c) Technological considerations play no role.

(d) Only the limitation of physical life constrains the alternatives (A to 12 and B to 8 years).

(e) The only costs are the uniformly recurring ones shown.

(f) The annual cost of alternative A exceeds that of alternative B.

(2) Alternative B costs less per year, but A provides benefits over a longer period of time, and the requirement is open-ended. If it is assumed that each alternative can be repeated with the same cash-flow pattern, A can be repeated once and B twice, resulting in the pattern shown in figure 4-5.

(3) Now both alternatives extend to a common point in time. In this case, it is clear that alternative B is the best economic choice.

c. In practice, cash-flow patterns are not so simple. Usually, there are investment costs and other one-time costs. Also, the annual recurring costs may not be uniform over time.

d. The EUAC converts each option into an equivalent, hypothetical alternative having uniform recurring costs. The conversion is such that the total NPV costs of the actual alternative and its hypothetical equivalent are the same. The hypothetical alternatives can then be compared. The best hypothetical alternative corresponds to the best actual alternative, which is the best economic choice for the project.

e. The EUAC calculation method--

(1) The NPV is determined.

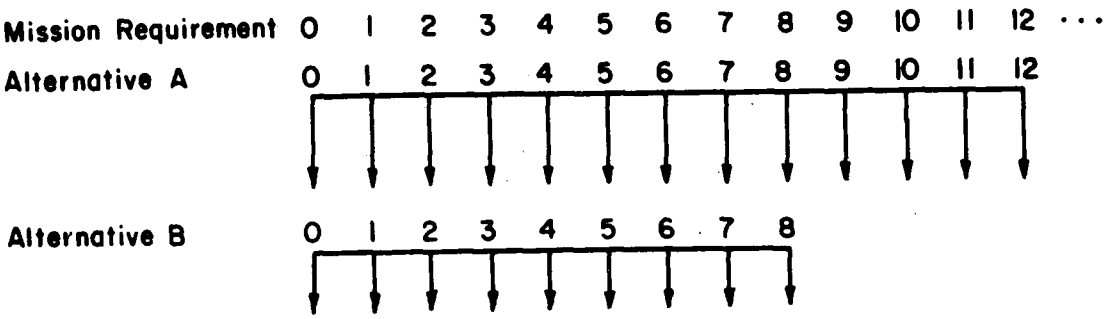


Figure 4-4. Cash-flow diagram for unequal economic lives.

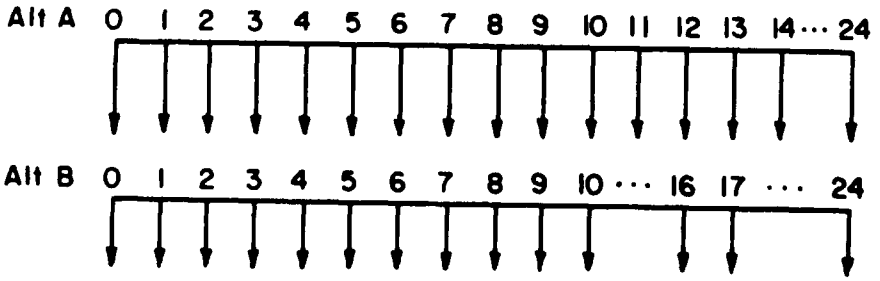


Figure 4-5. Cash-flow diagram for repetitions of lives.

(2) The NPV is divided by the sum of the discount factors for the economic life of the alternative. Thus, the formula for finding EUAC is--

$$EUAC = \frac{NPV}{b_n} \qquad \text{(eq 4-4)}$$

where b_n represents the nth year cumulative discount factor.

f. The EUAC represents the amount of money that would pay for the project if it were budgeted in equal yearly installments. This is not the same as taking a simple average. For example, a building with a 25-year life and an acquisition cost of $100M would have a simple average annual cost of $4M.

(1) Using the EUAC method (10 percent discount rate, end-of-year), the annual cost would be about $10 million since--

$$EUAC = \frac{NPV}{b_n} = \frac{\$100M}{9.077} = \$11.02M$$

(2) Using a simple average to find an annual cost for an EA is incorrect because it fails to allow for the time value of money. The EUAC incorporates the time value into its formula. In the example above, the significance of the $11.02M is that if $11.02M were spent for each of 25 years, the total NPV of the payments would be $100M, the same as the actual NPV cost of the alternative.

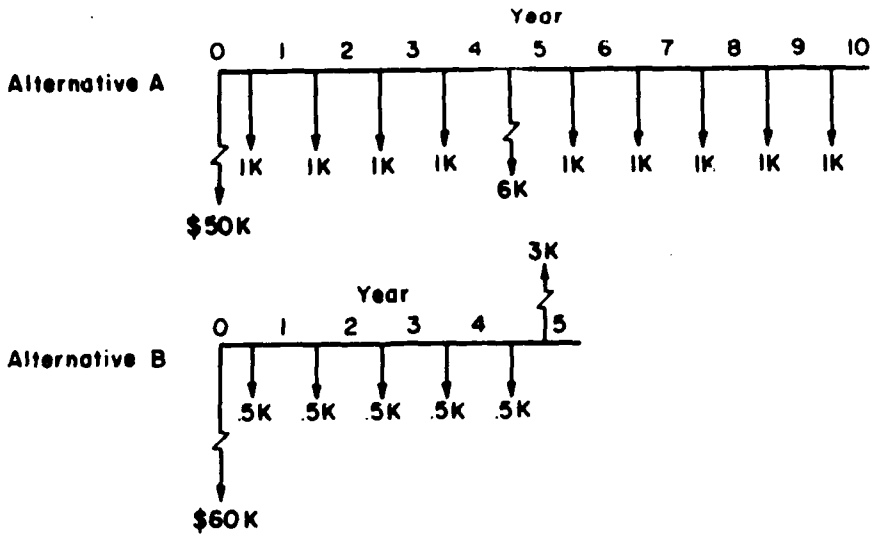
g. Figure 4-6 shows an example of computing the EUAC for two alternatives using a 10 percent discount rate.

h. In most MILCON EAs, the alternatives do have equal economic lives as they all must meet the mission requirement. Thus, the *NPV* is used to compare alternatives.

4-6. Benefit/cost ratio (BCR)

A complete EA will identify and quantify all relevant costs and benefits of each alternative. Both costs and benefits expected for each alternative will be considered. "Benefits" is an overall term for returns (savings, outputs, products, or yields). The benefits of each alternative must be expressed so that the decision-maker can make valid comparisons. This step is done using the benefit/cost ratio (BCR) method. In general, the BCR for each alternative is expressed as--

$$BCR = \frac{NPV\ of\ Benefits}{NPV\ of\ Costs} \qquad \text{(eq 4-5)}$$



Alternative A has an initial cost of $50,000 at the beginning of year 1, an annual cost of $1,000 occurring mid-year, and a one-time cost in year 5 (mid-year) of $5,000. (Note use of a broken line to show a cost is not to scale.) Using a 10 percent rate (mid-year), the EUAC is calculated:

$$NPV_A = \$50,000 + \$1,000(6.444) + \$5,000(0.651) = \$59,699$$

$$EUAC_A = \frac{NPV_A}{b_{10}} = \frac{\$59,699}{6.145} = \$9,715$$

Note: even though the discounting convention used is mid-year for all costs, the *cumulative factor* used to calculate the EUAC is *end-of-year*. This method will also be used in the ECONPACK computer programs.

Alternative B has an initial cost of $60,000, annual costs of $500 and a salvage value of $3,000 occurring at the end of year 5. The EUAC is calculated as follows:

$$NPV_B = \$60,000 + \$500(3.976) - \$3,000(0.621) = \$60,125$$

$$EUAC_B = \frac{NPV_B}{b_5} = \frac{\$60,125}{3.791} = \$15,860$$

Alternative A is preferred because its EUAC is much smaller than that of alternative B.

Figure 4-6. Example of calculating EUAC.

Benefits are measured in dollars. Total benefits relative to total costs are measured. The larger the BCR, the more cost-effective the alternative.

a. Benefit types. In general, four types of benefits are potentially associated with MILCON projects. These benefits are not mutually exclusive. They include--

(1) Direct cost savings.

(2) Efficiency/productivity increases.

(3) Other quantifiable output measures.

(4) Nonquantifiable output measures.

b. Direct cost savings. When direct cost savings are the main reason for performing an EA, a primary EA is usually done. These savings can result from a modernization or renovation or from an alternative such as constructing a new facility. The key aspect is that savings will accrue, usually in the form of a reduction in recurring O&M costs. That is, after an initial investment, the funding level needed for the facility and its function will be reduced in future years:

Year	Project A Recurring O&M	Project B Recurring O&M	Differential Cost (Savings)
1	1.5	0.7	0.8
2	1.5	0.7	0.8
3	1.5	0.7	0.8
4	1.5	0.7	0.8
5	1.5	0.7	0.8

(1) In the above example, direct cost savings are the net difference between the O&M costs of the two projects. (The BCR is calculated by dividing the total discounted benefits by the total discounted costs.)

(2) When the NPV of these savings exceeds the investment, the project "pays for itself" over its economic life and is self-amortizing.

(3) A primary EA is performed for such projects. The self-amortizing is demonstrated by an SIR greater than unity. Sometimes a project will not produce an SIR greater than 1 but will produce a partial self-amortization of interest to decision-makers.

(4) An example would be installing new, energy-efficient lighting in parking areas and on streets. Suppose the SIR is 0.70. The fact that the project is mostly self-amortizing, plus the added benefits of increased morale and security/safety, may well justify the project.

c. Efficiency/productivity increase ratio (EPIR). Often projects such as modernization, rehabilitation, and consolidation increase an operation's efficiency or

productivity. These increases are very beneficial and should be included in the BCR analysis when they exist. Benefits of this type are often confused with direct cost savings because they are easy to quantify in dollar terms. However, they are not equal, and the analyst should understand the basic difference.

(1) An increase in efficiency or productivity implies only one result: the ability to do more work within the existing manpower and funding levels. One way to translate an efficiency/productivity increase into direct cost savings is to effect a reduction in force (RIF) which lowers the required personnel funding level. The other way is to use the same manpower level to meet an increased workload requirement. A RIF is not usually intended as one of the required results of a MILCON project, and thus some other means of quantifying efficiency/productivity benefits must be used.

(2) An efficiency/productivity increase that translates into a labor/time savings of 2 manyears is a benefit whose value can be defined as what it would cost the Army to pay for an additional 2 manyears of labor. This cost should be accelerated by the appropriate rates for leave and fringe benefits because the value of the benefit should reflect the actual *total cost* to the Army of providing 2 manyears of work.

(3) One very important policy must be mentioned at this point. To claim an efficiency/productivity increase as a valid benefit, there must be a documented need for the increased workload capacity. In other words, there must be an alternative use to which the manpower resources now available can be applied, such as reducing a backlog of maintenance. Without this justification, there is *no benefit*--at least no *quantifiable* benefit--derived from the project.

d. Other quantifiable output measures. Many MILCON projects, especially industrial projects, have a stated goal defined in terms of required outputs. This goal is not always quantified. However, sometimes an analyst can find a way to quantify the goal and thus devise a way to measure the potential benefits associated with the project. This project backup data, to be of use to decision-makers, should relate goals to quantifiable levels of output when possible. These levels can then be used to measure the benefits of a project.

(1) This benefit category applies most often to projects that must have a secondary EA done, in which alternative methods of satisfying a validated facility deficiency are compared. This comparison is made easier by finding an annual BCR (ABCR) for *each* alternative:

$$ABCR = \frac{\text{Annual benefit/output measure}}{EUAC} \qquad \text{(eq 4-6)}$$

(2) In equation 4-6, the EUAC is found as described in paragraph 4-5. The annual benefit/output measure (ABOM) is a quantified statement of expected yearly output for the alternative under investigation. Examples of ABOM are--

(a) Number of vehicles overhauled per year.

(b) Number of miles of road resurfaced per year.

(c) Cubic feet of sewage treated per year.

(d) Number of soldiers trained per year.

(e) Kilowatt-hours of electricity produced per year.

(f) Antennas overhauled and tested per year.

(3) For example, assume that because of a regional consolidation, an Army tank maintenance facility is now responsible for all corrosion-control maintenance for all Army tanks in the northeast United States. Further assume that the facilities engineers have done a detailed feasibility and concept study and decided that there are only two reasonable alternative methods of satisfying this operational requirement:

(a) Modify existing unused space to accommodate the corrosion-control function. Expected life is 25 years.

(b) Demolish the old space and build a new, highly efficient, semiautomated corrosion-control facility. Expected life is 25 years.

(4) Table 4-1 contains the data for this example. The table shows that, although the new facility alternative is more expensive, the benefit (output) per equivalent annual dollar spent is 31 percent higher than that for the modification alternative: 1.67/1.28 = 1.30.

Table 4-1. Example of annual benefit output measure (ABOM)

Item	Modification	New Construction
Recurring annual expenses (personnel, O&M, etc.)	$100,000	$85,000
26-year cumulative discount factor	9.608	9.608
PV of recurring cost	$960,800	$816,680
Investment (year 1)	$2,000,000	$2,600,000
Year 1 discount factor	0.953	0.953
PV of investment	$1,906,000	$2,477,800
NPV	$2,866,800	$3,294,480
EUAC (use end-of-year, 9.161)	$312,935	$359,620
Benefit/output (maintenance jobs performed)	400/year	600/year
BCR (completed maintenance jobs per year per $1,000)	1.28	1.67

(5) The new construction alternative is likely to have a more favorable effect on increasing tank life:

$$\text{New construction: } \frac{2{,}000 \text{ tanks}}{600 \text{ tanks/year}} = 3.3 \text{ years/maintenance}$$

$$\text{Modify space: } \frac{2{,}000 \text{ tanks}}{400 \text{ tanks/year}} = 5 \text{ years/maintenance}$$

(6) Suppose there are 2,000 tanks in the northeast United States. Thus, with new construction, a tank can undergo corrosion control about every 3.3 years. With the modification alternative, there will be at least 5 years between corrosion control measures. Although both maintenance cycles are acceptable, more frequent corrosion control is preferred because of the cumulative effect of corrosion.

(7) No significance should be given to the relation of the ABCR to the number 1. Unlike the SIR, EPIR, and BCR, the absolute size of the ABCR is not important. This is because of the dimensional quality of the ABCR and the arbitrarily chosen baseline (that is, completed maintenance jobs per year per $1000). Thus, the only valid comparison is between the two ABCR measures. (The reader should not confuse this situation with that of a nondimensional SIR, in which unity has vital significance.)

(8) The various BCR methods should be used *only* when the unit of measure for the benefits and costs of each alternative is the same. If this is not the case, the BCR, like any other measure, will confuse important information and can be misleading.

e. Nonquantifiable output measures. It is not always possible to quantify some benefits such as improved morale, increased retention rates, better troop quarters, and other qualitative benefits. However, they should be documented in the EA report for consideration by the decision-makers. These written qualitative benefit descriptions can make a positive contribution to the EA. Statements on qualitative benefits should follow these guidelines:

(1) Identify all benefits associated with each alternative and give complete details.

(2) Identify benefits common in kind but not in extent or degree among alternatives, and explain the differences.

(3) Avoid platitudes. For example, all prospective projects are worthwhile because they support national defense, and statements to this effect are not needed.

(4) Display the benefits in tabular form such as--

	Increased Morale	Safety	Unit Integrity
Alt A	Yes	Same	Better
Alt B	No	Same	Same

f. In summary, this paragraph has outlined methods that can be used to evaluate and portray benefits in a benefit/cost analysis framework. These methods are not exhaustive, but illustrate approaches the analyst can take to evaluate the benefits of different options. Analysts should use these methods in addition to any others they find appropriate. If a unique method is used, the analyst should clearly and completely explain, justify, and document it for the EA report.

(1) Benefit analysis should be reported in a separate section of the report (see chap 8).

(2) Negative aspects of an alternative should also be reported and quantified when possible. This information is important to the decision-maker and may be a determining factor in selecting an alternative.

g. The methods described in this chapter can be used to perform EAs for all MILCON and CFF projects. Some methods work better for certain combinations of costs and lives than others. Once an analyst has done several EAs, selection of the method(s) will become second nature. To assist beginners, figure 4-7 shows combinations of type of analysis, equality of lives, costs, and benefits, and the decision process used to define which technique(s) to use.

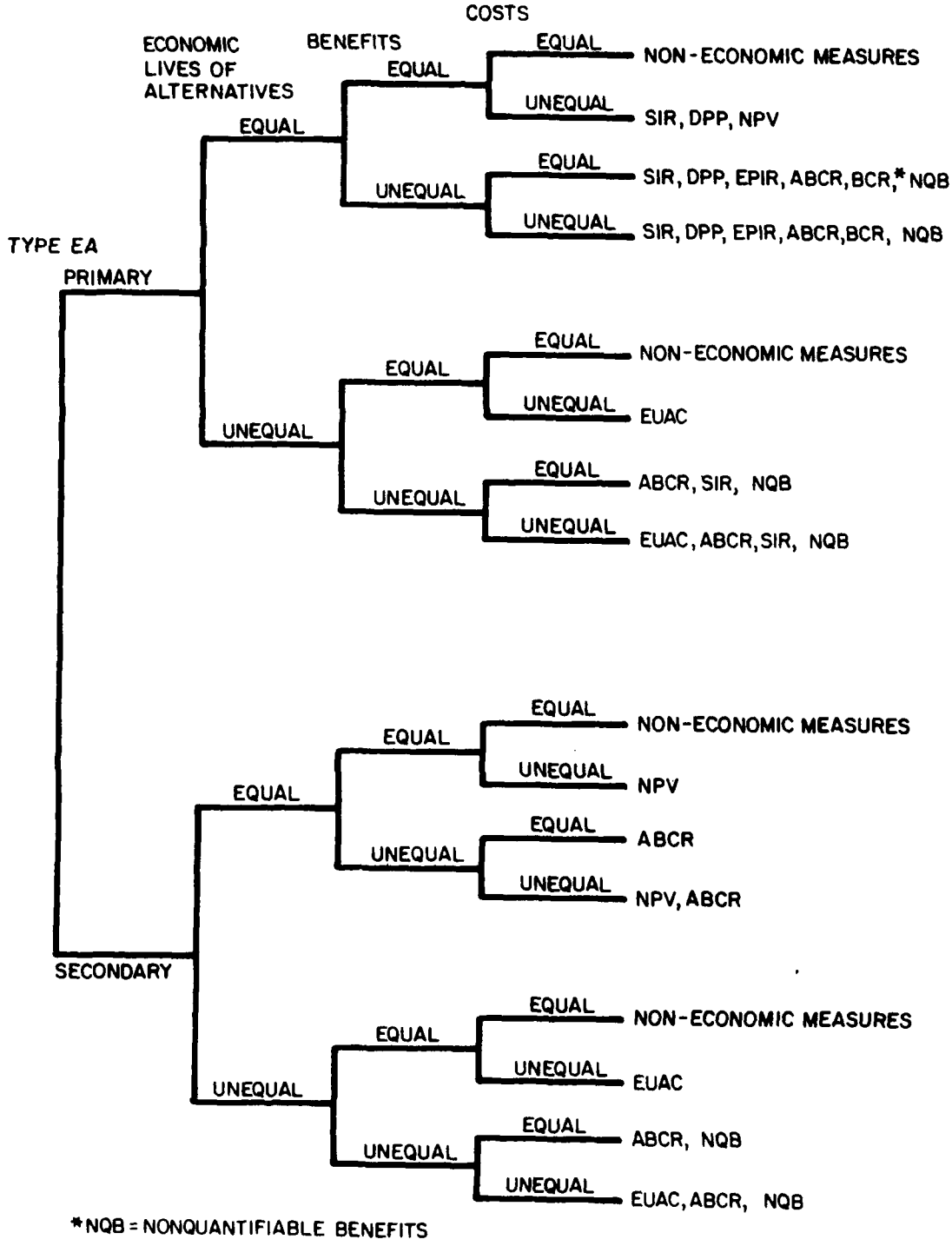


Figure 4-7. General process for determining which EA method to use.

5 DESCRIPTION AND ESTIMATION OF COSTS

5-1. Definition of costs

a. A cost represents the value of a resource. It is the value, measured in dollars, of resources required for an alternative. These costs include materials, labor, maintenance, supplies, and capital spent in producing goods or services. A proper cost analysis of an operation requires that the amount and timing of all costs be determined for each alternative. These costs must be calculated for the entire period of analysis (life-cycle costing).

b. Costs can be tangible or intangible. Tangible costs are those related to resources such as labor, material, equipment, and supplies. These costs can be estimated and, in the EA, have a definite dollar value. Intangible costs are those with no dollar value assigned. Costs such as increased or decreased morale, convenience, unit integrity, and satisfaction are all intangible. While these may be listed, discussed, and used to aid in making a decision, they usually have no values that can be quantified.

5-2. Cost elements

a. General. Cost elements, if present, that must be addressed in an EA are discussed below. This is a very detailed list--no one EA is ever likely to have all of them. They are listed to ensure that the analysts consider all potential costs. If analysts find a cost not on the list, they will include it in the EA. Analysts perform the EA as representatives of the U.S. Government and the taxpayer, and therefore should include all relevant costs.

(1) Construction contract costs. This is usually the major first cost incurred to build the facility. All costs to construct the facility are included: design, construction, contract administration, inspection, supervision, and any other costs associated with the construction process. Sources of data for these costs are AR 415-17, division and district offices, installation Directorates of Engineering and Housing (DEHs) and historical data for similar projects.

(2) Renovation/rehabilitation. These are major costs that can occur initially or in outyears to renovate or rehabilitate a facility. Costs and year of occurrence estimates can be obtained from the DEH, district and division offices, and cost-estimating guides.

(3) Maintenance costs. These are annual recurring costs of normal maintenance for a facility. They include costs for preventive maintenance and minor repairs. Data for these costs can usually be estimated best by the installation DEH based on historical records.

(4) Periodic repair/replacement costs. Costs to replace a roof, the exterior finish, the floor covering, the air conditioner, or heating plant, and to repaint the exterior are typical in this category. Good data sources for these costs are the DEH and cost-estimating guides such as Means and Dodge.

(5) Utility costs. Energy source costs such as gas, oil, coal, electricity, and wood are included here. Water and sewer costs are also in this category. Any communications costs can be included. Data can be obtained from the DEH and companies providing the utility.

(6) Lease cost. This is the monthly or yearly charge to the government to lease an asset. Estimates for facilities leases can be obtained from district real estate offices, the General Services Administration, and commercial firms in the locale. Equipment lease rates can be obtained from local or national leasing companies.

(7) Administration costs. These costs are salaries for the facility management staff (such as the housing office personnel) or for the contract manager in the case of a lease. These costs can be obtained from the DEH.

(8) Equipment costs. Equipment includes material handling, production lines, central or domestic laundries and kitchens, nonmedical hospitals, power/heat generation and distribution, fuel handling, utilities distribution and sewage treatment. Data can be obtained from the DEH and Directorate of Industrial Operations (DIO).

(9) Furnishings costs. These costs include office and household furnishings. The DEH and DIO are possible sources for cost data.

(10) Services costs. These costs are snow removal, trash hauling, security, custodial, and entomological. Data sources are the DEH and DIO.

(11) Personnel costs. These costs are for military, civilian and contractor personnel. They are for operating a facility or vehicles associated with the alternative. Salaries can be obtained from Office of Personnel Management (OPM) documents or the local resource management (comptroller's) office.

(a) For civilian personnel, the labor costs are calculated by using the current pay rate as published, plus the Government's contribution for retirement, location differential, disability, health, life insurance and, where applicable, social security. An additional 26 percent for these costs will be added to the basic pay (retirement = 20.4 percent, insurance = 3.7 percent and bonus, compensation, unemployment, and awards = 1.9 percent).

(b) The cost of military personnel is calculated by using the standard rates set by DOD for expensing military personnel services. These rates include basic, incentive, and special pay, plus certain other expenses and allowances paid from Military Personnel, Army (MPA) appropriations. (See AR 37-100 for more information.) Adjustments must be made to reflect the Government's contribution to retirement and other costs by multiplying by the percentages shown in table 5-1.

Table 5-1. Government contributions for military personnel services (based on percentage of gross pay)

Allowance	Officer (%)	Enlisted (%)
Retirement	26.5	26.5
Other benefits	8.0	23.0
Total	34.5	49.5

(c) Costs for pay and employee benefits of host country national or third country national employees must also be included when applicable. The military pay rate of officers shall be increased by 61 percent and for enlisted personnel by 79 percent.

(12) Allowances. These costs include Basic Allowances for Quarters (BAQs), Variable Housing Allowance (VHA), Household Goods (HHG), and temporary duty (TDY). They are available from the DEH and the Finance and Accounting office.

(13) Land. This is the cost to acquire land from the private sector. It is available from the district real estate office.

(14) Residual/terminal value and demolition costs. The residual (or terminal) value at the end of the period of analysis represents the market value at that time. The residual/terminal (salvage) value of a facility is usually a negative cost (inflow of funds) and must be accounted for in the EA. The value is discounted and subtracted from the overall costs of the alternative. A demolition cost is incurred if Army funds are used to remove a facility. This cost is added to the overall costs of an alternative.

(a) The residual or terminal value is estimated on the basis of use, obsolescence, rehabilitation possibilities, and market value. Estimates of these costs can be obtained from the DEH, district real estate offices, and commercial real estate firms. Factors for estimating building decay-obsolescence and site appreciation have been developed and are given in table C-1 (appendix C). These can be used in lieu of local estimates.

(b) For projects outside the continental United States (OCONUS), the analysis must include estimates of both residual value and the probability that the Status of Forces Agreement (SOFA) will result in a residual value of zero.

(c) It is common to calculate the terminal value using straight-line depreciation. A residual value can also be calculated using the declining balance method or the analyst's own depreciation schedule.

(d) As an example of straight-line depreciation, suppose a building has an initial cost of $1M, with an economic life of 40 years. The period of analysis is 25 years. The value of the building will decrease by $1M/40 years = $25K/year. At the end of 25 years, its terminal value is calculated as--

$$\$1M - (\$25K/yr)\ (25\ yr) = \$375K$$

(15) Inherited assets. When an alternative involves the use of an existing asset, its value may be included in the analysis as a cost. The value at the base year of analysis is estimated. However, if the asset has no other use and is not intended to be sold, its value will not be included in the analysis.

(16) Insurance. For certain analyses involving leases, the cost of insurance to the contractor is included. Sources for this data are OMB Circular A-104 and local insurance firms.

operating personnel in addition to any cost for transported personnel such as student trainees. Data sources are the DEH, DIO, and local private transportation firms.

(18) Communications. This is the cost for purchasing and installing communications equipment. It includes the annual cost for communications service.

(19) Property taxes. For certain lease analyses, property taxes are included. Tax amounts can be obtained from the district real estate office and the local assessor's office.

5-3. Cost kinds

a. General. Costs are grouped into 18 kinds. Some of these are composed of several cost elements. Table 5-2 lists the cost elements that may be contained in a cost kind. Note that table 5-2 is a guide; it must be interpreted for each alternative in an analysis. An alternative may not involve military personnel costs, even though this element is listed under personnel costs. Or, there may be no heat-generating equipment as the alternative may use steam from a central plant. Table 5-2 is not all encompassing, but includes most common cost kinds. Each kind is defined below and examples are given. Use of table 5-2 will aid in consistently classifying cost elements into cost kinds, resulting in an EA which is easier to review at higher levels. The 18 cost kinds discussed below are--

(1) Initial investment.

(2) Personnel.

(3) Administration.

(4) Utilities.

(5) Periodic repair/replacement.

(6) Services.

(7) Travel/transportation.

(8) Allowances.

(9) Furnishings.

(10) Equipment.

(11) Salvage/demolition.

(12) Maintenance.

(13) Land.

(14) Insurance.

Table 5-2. Cost elements of typical cost kinds

Cost Elements \ Cost Kinds	Initial Investment	Personnel	Administration	Utilities	Periodic repair/ replacement	Services	Travel/Transportation	Allowances	Furnishings	Equipment	Salvage/Demolition	Maintenance	Land	Insurance	Property Taxes	Lease	Inherited Assets	Communications
Construction Contract	x	x																
Renovation	x	x			x													
Maintenance									x			x						
Periodic repair/ replacement					x													
Electricity				x														
Gas				x														
Heating/cooling				x														
Water and Sewer				x														
Administration/ Management		x	x															
Equipment procurement				x						x								
Equipment maintenance	x	x								x		x						
Office furnishings									x									
Household furnishings									x									
Snow Removal						x							x					
Entomological						x												
Trash Removal						x												
Custodial						x												
Security						x												
Operating Personnel		x	x	x														
Allowances								x										
Land													x					
Lease																x		
Residual											x							
Demolition	x										x							
Inherited Assets	x																x	
Insurance														x				
Communications																		x
Property Tax															x			
Travel		x					x											
Transportation		x					x											

(15) Property taxes.

(16) Lease.

(17) Inherited assets.

(18) Communications.

b. Initial investment. These are first costs incurred for an alternative. For construction of a new facility or renovation/ rehabilitation, they include the design, cost, construction contract cost, supervision, and administration of the construction contract, any research and development costs, and site preparation costs.

c. Personnel. These are costs for military and civilian personnel who will be employed to operate or manage a function. For production-type facilities, this cost can be a crucial part of the EA, as different alternatives may allow different production line designs that require different numbers of personnel. These costs can also cover transportation time for occupants in going from one facility to another.

d. Administration. This cost involves the management of the facility or lease costs. It occurs frequently in a housing function where time of managers and assistants is required to manage housing units. It does not include the normal costs of occupants in management of their space.

e. Utilities. This cost kind includes all utilities consumed--whether provided by the Government or by contract. Costs are for gas, electricity (purchased or generated), oil, wood, coal, water, and sewer. They do not include construction and maintenance costs of utilities plants or distribution lines.

f. Periodic repair/replacement. These costs are major one-time or periodic costs occurring during the life of the project. They include costs such as replacement of a roof, overhaul or repair of an air-conditioning system, remodeling the kitchen of a house, and rewiring a building. Major renovation or rehabilitation expected to occur in the future is included. For any project of 20 years or more, several of these costs should occur.

g. Services. Trash hauling, snow removal, entomological work, grounds maintenance and security are all of this kind.

h. Travel/transportation. One cost kind is concerned with transportation (shuttle service) of personnel using the facility or of bringing equipment and materials to the facility. An example would be if a training facility is leased offpost and trainees must be bused to and from it. Costs would be incurred for the driver's salary and for the vehicle, including maintenance and fuel. Or, it could be the contract cost to obtain bus service. Another cost of this kind is the per diem for personnel awaiting quarters.

i. Allowances. These costs include allowances for quarters. The BAQ is provided to military personnel who live on the economy. VHA, Rent Plus, Family Separation Allowances, and Temporary Living Allowance (after permanent change of station moves) are other costs within this kind.

j. Furnishings. This is the cost of furnishing a facility. For housing, it includes the furnishings and their replacement, maintenance, repair, storage, distribution, security, and all other property management functions. For nonhousing, it may include office

furniture if the cost varies between options. Otherwise, it is a wash cost and need not be included in the analysis.

k. Equipment. This cost kind is a very broad category and can vary from a refrigerator in a house to a heavy crane in a maintenance shop. It includes kitchen equipment in a dining hall, refrigeration equipment in a hospital, a boiler in a heat generating plant, a gas line and an electrical power line. This kind is often a wash cost as all alternatives will use the same equipment.

l. Salvage/demolition. This cost kind can be either positive or negative. If a facility has a salvage or residual value at the end of the analysis period, then that value represents an inflow (negative cost) of funds to the Government. In contrast, if the facility must be removed or demolished, there will be an outflow (positive cost) to the Government.

m. Maintenance. This cost kind contains annual maintenance costs such as those normally done through service orders. It also includes ongoing maintenance such as that done with standing service orders and any periodic maintenance such as a biyearly inspection of a facility. Preventive maintenance also is included. Any maintenance and repair costs not considered a major repair or replacement falls into this cost kind.

n. Land. Both land purchases and costs of easements are in this category. In analyzing certain lease options, the imputed cost of land owned by the Government must be estimated.

o. Insurance. This is the cost of insuring a privately held asset. The Government is self-insured and insurance costs are used only when leasing is one of the alternatives (chap 7).

p. Property taxes. These costs are included in certain types of lease analyses and are imputed for the Government. Estimates of these taxes are based on taxes assessed for comparable private property.

q. Lease. This is the annual charge to the Government for leasing a facility or asset in the private sector.

r. Inherited assets. In some cases, an alternative will use an existing asset. If so, its value at the base year of the analysis will be a cost and must be included in the analysis since the asset could alternately serve another purpose. However, if the asset has no use or value except in the alternative, no cost is included.

s. Income tax. Currently, the normal payment of income tax by the private sector in leasing alternatives need not be considered.

5-4. Cost estimation methods

a. Perhaps the most difficult phase of an EA is the estimation of costs. However, this part of the EA is crucial because the results will only be defendable to the extent that the cost estimates are reliable. Estimates can never be 100 percent precise as they are made several years before the costs will actually occur. This implies that inflation will have an impact, but inflation rates vary over time and location. Standards such as level of maintenance for a facility also may vary in the future, which will change the maintenance cost of the facility. Estimates must be as precise as possible given the

constraints on the analyst in performing the EA. Precision is usually obtained by acquiring as much detailed data as possible. Most cost estimates are based on historical data.

b. The analyst chooses the proper level of detail and accuracy in the estimates. These must be weighed with the time allowed to obtain the estimates. Detail and accuracy can be of three levels:

(1) Order-of-magnitude estimates. The accuracy of these estimates is very low and can differ from the actual cost by as much as 50 percent. These are used when there is not enough time, funds, or both to do a detailed one or when the magnitude of the cost is so small that large inaccuracies will not be a determining factor in the analysis.

(2) Good estimates. Good estimates are those for which accuracy is about 10 percent of the actual cost. For many costs in an EA, these types will suffice because of the analysts' cost in increasing accuracy.

(3) Detailed estimates. These estimates will normally be within 5 percent of the actual costs. They are often derived from detailed plans and specifications or from accurate historical records. These estimates should be used when possible to ensure the validity of the analysis.

c. Cost estimates must be made with care and with full knowledge of their limitations. The limitations (assumptions) must be fully documented in the EA report. The accuracy of the estimates must be assessed and tested for impact on the analytical results by use of sensitivity analysis. There are three primary methods of cost estimation:

(1) Analogy method. This is perhaps the most widely used method. In some cases, the analyst must make judgments when using this method. If so, they must be documented properly in the EA report.

(a) This method is used often in estimating facility acquisition or renovation costs. Historical construction costs for similar facilities on the installation or in neighboring communities can be used.

(b) Estimates of annual recurring costs are often obtained by this method when the analyst can obtain current, accurate records of costs such as roofing lives and repairs, custodial costs, and energy consumption for similar types of facilities. Application of these cost records requires expert judgment and experience by the analyst and the DEH staff.

(2) Industrial engineering method. In this method, estimates from various separate segments of the project are combined into a total project estimate. It is commonly used in projects involving production-type situations such as maintenance shops and ammunition production facilities. However, the principles behind it can be used for any type of analysis.

(a) The analyst must have extensive knowledge of the system, operating processes, and organization. The system is divided into its components and estimates of each component are made. This breakdown allows the analyst to determine which costs are known and thus where effort must be directed to obtain estimates. This process allows an emphasis on estimating costs for which little information is available.

(b) In some cases, industrial engineering techniques such as work measurement and time-and-motion studies may be needed to make the estimates. In other cases, the analogy method may be used.

(c) Once the costs have been estimated for each lower level component of the system, they are combined to obtain the estimate for the whole system.

(d) Because this method is so detailed, it can result in very accurate estimates. However, it can be very costly to obtain such estimates. When detailed data exist or are easy to obtain, this method is the best one.

(3) Parametric method. In this method, the total cost of an alternative or some part thereof is based on specified physical and performance properties and their relationships to component costs. In other words, a functional relationship is established between the total of an alternative (or some part) and the various properties of its parameters. The term "parameter" is defined as a cost-related explanatory attribute that may assume various values during actual calculations.

(a) A parametric estimate depends directly on the ability of the analyst to set up relationships between the attributes that comprise the alternative. The analyst must select and describe the cost-influencing factors of the alternative. For example, the construction of family housing involves (among others): the number of stories; the number of dwelling units in the building; the number of bedrooms, baths, dens, and recreation rooms; floor area of the various rooms; garage size; and lot size. If house prices are known for various combinations of these parameters, prices for other parameter mixes may be estimated relative to this baseline.

(b) Ease of estimation and accuracy of estimates increase with the increase in number of actual combinations for which prices are known. Given many combinations, the analyst can develop a valid cost estimation relationship. Statistical techniques such as regression analysis can be used to develop equations that describe such relationships.

5-5. Sunk and wash costs

a. A "sunk" cost is one that will occur before the period of analysis. Sunk costs are past history. They will have no bearing on the future and are therefore disregarded in the EA.

b. A "wash" cost is one that occurs identically for all alternatives. Wash costs can be excluded from the EA since they will not affect alternative rankings or the SIR.

6 SENSITIVITY ANALYSIS

6-1. Discussion

Once all costs and benefits have been estimated, the analysis can be performed and the alternatives ranked to show which is economically best. However, the analysis is not complete until it has been examined for areas of uncertainty. Sensitivity analyses are used to evaluate the effect of these uncertainties on the ranking of the alternatives.

a. Some uncertainty is always present in economic decision-making and, thus, some type of sensitivity analysis must normally be done in an EA. In an EA, *future costs are predicted* and there is an element of uncertainty about these data. Even if actual cost data from past projects are used, it is *assumed* that these data are an accurate estimate of future costs. Thus, all data used in calculating life-cycle costs are actually based on assumptions. The sensitivity of an analysis is tested by evaluating a range of estimates for critical cost elements. The sensitivity analysis measures the percent change in one or more elements of an economic comparison that will reorder the ranking of alternatives.

b. No single criterion can be used to select the most important parameter or factor to be considered in sensitivity analysis. Each analysis has its own set of costs and assumptions.

c. A general rule when considering cost data is to examine the input variables. Variables that significantly impact the total NPV or the benefits of an alternative are good candidates for sensitivity analysis. An easy way to find these variables is to examine the percentage values of the present value of each cost against the net present value of the alternative. A rule of thumb is to examine all costs which are 20 percent or more of the total NPV for an alternative.

d. A sensitivity analysis is developed by asking the question: which input variables should be tested? That is, are there dominant costs with uncertainties concerning their magnitudes or their times of occurrence? Assumptions and constraints must be examined to determine if their variation affects the input variables.

e. As in the entire EA process, the analyst should use common sense in deciding which sensitivity analyses to perform. If the ranking of alternatives shows that one is much less costly than the others, it is probably not necessary to evaluate small changes in costs that have no chance of reversing the ranking. It is when the magnitude or timing of a cost may affect the ranking or when the economic choice is not clear cut that further investigation is needed. There is no formal theory for performing sensitivity analyses. Paragraphs 6-2 and 6-3 discuss the rationale and basic methods used most often in sensitivity analyses.

f. The analyst should not make the sensitivity analysis too complex, as interpretation can be very difficult. A good guide is to study only two alternatives at a time and vary the uncertain costs within each alternative in the same way (an increase or decrease).

g. The analyst should have a range of values of the uncertainty in mind before doing the sensitivity analysis. For example, the uncertainty should be envisioned as ranging from 50 to 150 percent of the estimate or, say, from 70 to 100 percent of the estimate.

6-2. Uncertain cost(s) in one alternative

The simplest case is when there is uncertainty for one or more costs in one alternative. In this case, the analyst can rerun the analysis, inserting the upper (or lower) bound value for the cost(s) in question. (Note: "cost" normally means the magnitude of the cost, but it could also be the timing of a cost.)

a. Example 1. Figure 6-1 shows the data, cash flow diagrams, and NPVs. There are two alternatives: new construction and renovation. The facility is required for 25 years, a 1-year construction or renovation time is needed, and a 10 percent discount rate is used. The base year to which all costs are discounted is year one.

(1) The renovation alternative is the best choice from an economical viewpoint as its NPV is $115,600 less than that of new construction. Suppose that there is a large amount of uncertainty in the O&M costs for renovation and that it could be as much as 50 percent larger. The NPV is calculated again using $45,000 as the annual cost. The new value is $1,115,125 which is $14,225 higher than the NPV of the new construction alternative. Thus, the results of the original analysis and ranking of the two alternatives are sensitive to the uncertainty in the O&M costs of the renovation alternative. An increase of 50 percent in the renovation O&M costs reverses the ranking of the alternatives.

(2) Equation 6-1 can also be written as--

$$NPV_{REN} = \$725,650 + 8.655(O\&M\$) \qquad \text{(eq 6-2)}$$

(3) This line can be graphed, showing values for the NPV as a function of the O&M cost. Figure 6-2 shows this relationship.

(4) The intersection of the lines representing NPVs for the new construction and renovation alternatives is at $43,356 or 44.7 percent. This intersection can be found by solving the equation directly:

$$\$725,650 + 8.655(O\&M\$) = \$1,100,900$$

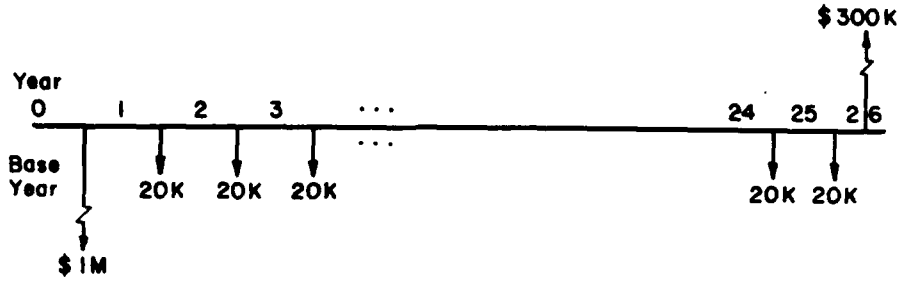
or--

$$O\&M\$ = \frac{\$1,100,900 - \$725,650}{8.655} = \$43,356$$

b. Example 2. Assume there is an existing method of maintaining certain shelters which is done in the open environment. Suppose an alternative method of doing the maintenance in an automated, environmentally controlled building is proposed. Figure 6-3 shows the cash-flow diagrams for the primary economic analysis.

New Construction

Initial cost is $1,000,000, annual O&M cost is $20,000, and residual value is $300,000.

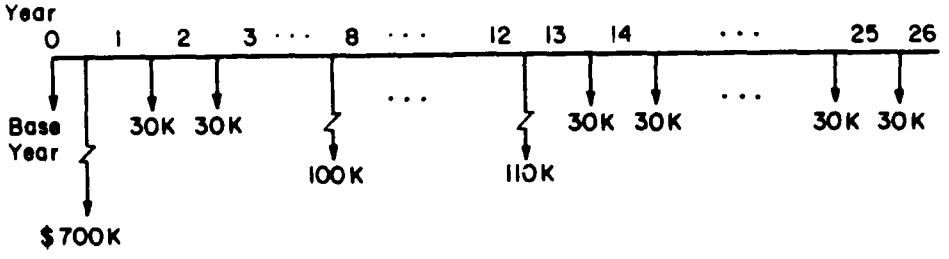


$$NPV_{NEW} = \$1,000,000(0.953) + \$20,000\ (9.608-0.953) - \$300,000(0.084)$$

$$= \$1,100,900$$

Renovation:

Initial cost is $700,000, annual O&M cost is $30,000, air-conditioner replacement will cost $70,000 in year 8, and roof replacement will cost $80,000 in year 13.



$$NPV_{REN} = \$700,000(0.953) + \$30,000(9.608 - 0.953) + \$70,000(0.489) + \$80,000(0.304) \qquad \text{(eq 6-1)}$$

$$= \$985,300$$

Figure 6-1. Example of uncertainty in cost(s) in one alternative.

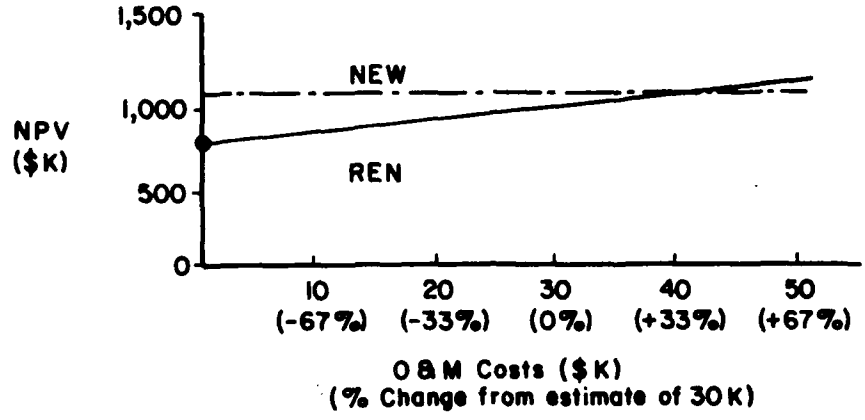


Figure 6-2. Graph of equation 6-2.

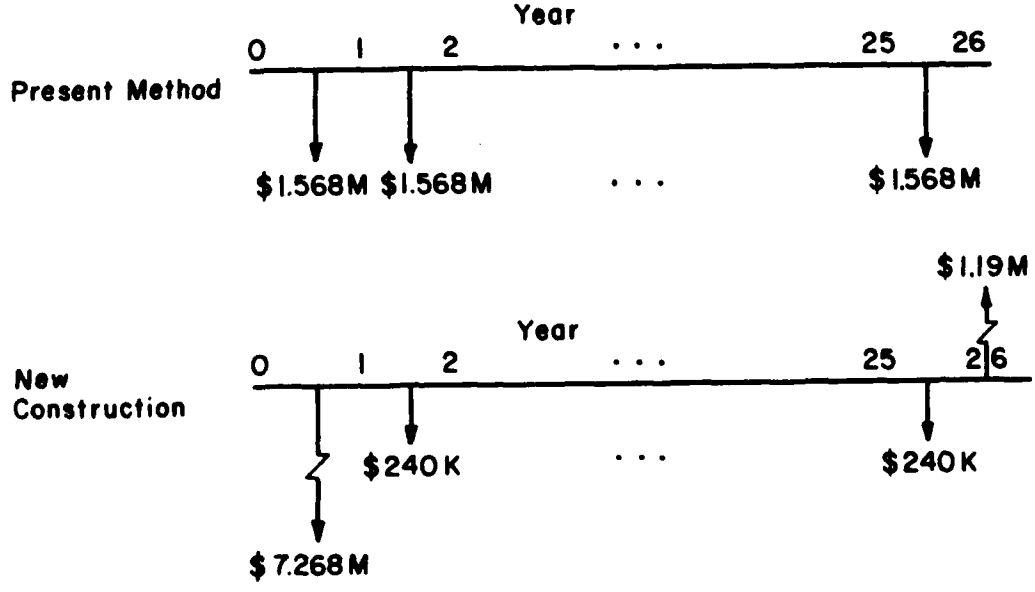


Figure 6-3. Cash-flow diagram for the shelter problem.

(1) The present method has only one cost--an annual operating cost of $1.568 million. The proposed alternative has an initial cost of $5.7 million, a first-year cost for the present method of operation of $1.568 million, an annual O&M cost of $240K, and a salvage value of $1.19 million. All costs are discounted (10 percent rate) to the beginning of year 1, the construction year. The SIR and DPP are calculated as follows:

$$NPV_{SAV} = (\$1,568,000 - \$240,000)(9.608)$$

$$= \$12,759,424$$

$$NPV_{INV} = \$5,700,000(0.953) + \$1,568,000\ (0.953)$$

$$- \$1,190,000(0.084)$$

$$= \$6,826,444$$

$$SIR = \frac{\$12,759,424}{\$6,826,444} = 1.87$$

(2) The DPP is calculated by determining when the NPV_{SAV} equals the NPV of the investment cost, $6,826,444 (the DPP starts after construction is completed):

Year	Cumulative NPV Investment	Annual NPV Savings	Cumulative NPV Savings
1	6,833,712	0	0
2	6,833,712	1,265,584	1,265,584
3	6,833,712	1,151,376	2,416,960
4	6,833,712	1,046,464	3,463,424
5	6,833,712	950,848	4,414,272
6	6,833,712	864,528	5,278,800
7	6,833,712	786,176	6,064,976
8	6,833,712	714,464	6,779,440
9	6,833,712	649,392	7,428,832

(3) Payback occurs in the eighth year and can be calculated as follows:

$$8.0 + \frac{6,826,444 - 6,779,440}{7,428,832 - 6,779,440} = 8.07$$

(4) Now the current operating costs are very accurate as is the construction estimate. However, the operating costs of the proposed alternative has a degree of uncertainty. The increase in these costs which would make the SIR = 1.0 (i.e., make the alternative undesirable) can be found by solving the equation for these costs:

$$SIR = \frac{(\$1,568,000 - O\&M)(9.608)}{\$6,826,444} \qquad \text{(eq 6-3)}$$

or--

$$O\&M = \$1,568,000 - \frac{\$6,826,444(SIR)}{9.608}$$

$$= \$1,568,000 - \$710,495(SIR)$$

(5) For an SIR of 1.0, the O&M$ = $857,505. That is, the estimate of O&M costs would have to increase by--

$$\frac{\$857,505}{\$240,000} = 3.57 \text{ (357 percent)}$$

for the proposed alternative *not* to save money. Equation 6-3 can be graphed as shown in figure 6-4 to display the relationship and to present the results to management.

6-3. General analysis—uncertain cost(s) in two alternatives

a. The more complex situation is the general one in which one or more costs in each of the two alternatives has uncertainties associated with them. Figure 6-5 depicts the one-variable possibilities as well as the more complex situation.

b. In the simplest case of uncertain cost(s) in only one alternative, the NPV of the alternative containing the uncertain cost(s) will either increase or decrease while the NPV of the other alternative will not change. In the more complex sensitivity analysis, the NPV of one alternative can increase while that of the other decreases as the uncertain costs vary, or both NPVs may increase or decrease at once. In each of the three cases shown, there is a reversal of ranking for the two alternatives.

c. The solution to the complex situation is actually very simple. The NPV of each alternative is expressed as a function of the uncertain costs and then the NPVs are set equal to each other. The result is an equation in terms of the percentage change in the costs for each alternative. Figure 6-6 shows an example for this type of problem.

d. ECONPACK has a sensitivity feature that calculates all values within the range of uncertainties specified for which the ranking is reversed. See paragraph 8-5.

e. For CFF EAs, a sensitivity analysis of the discount rate used in the analysis is required. This analysis tests the effect of changes in discount rate on the ranking of alternatives. ECONPACK also performs this analysis (see chap 7).

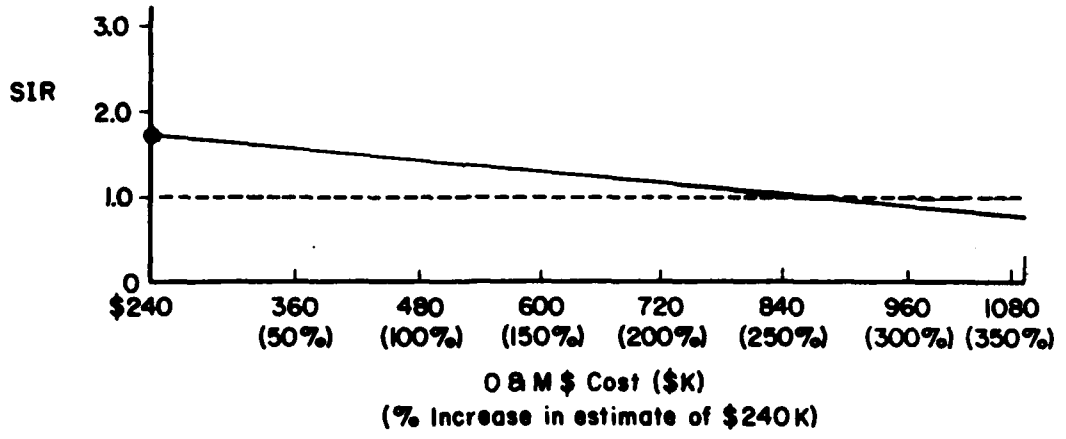
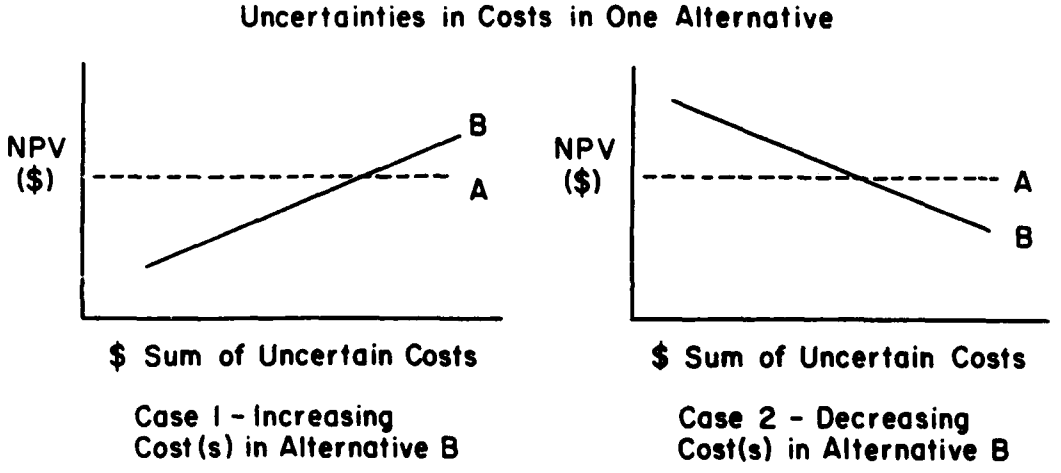


Figure 6-4. Graph of equation 6-3.



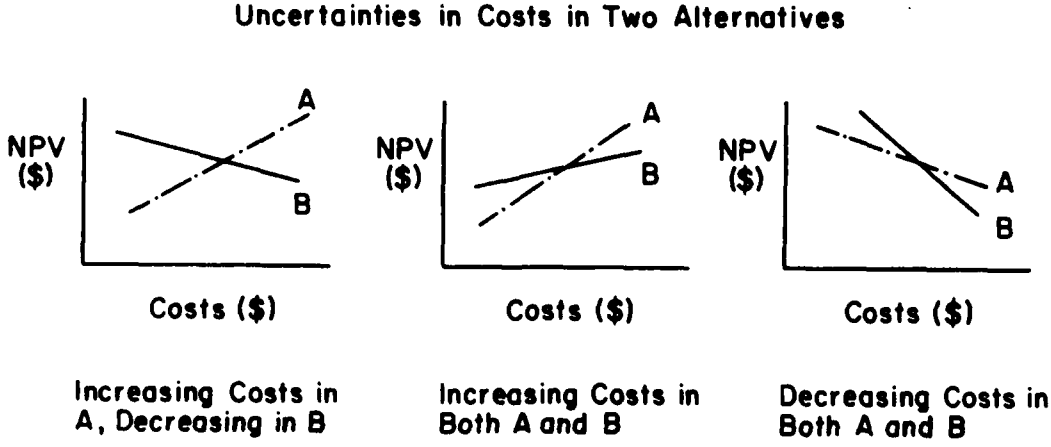


Figure 6-5. Graphs showing relationships between NPVs of alternatives with uncertainties.

The data in figure 6-1 are used for this example.

Suppose there is uncertainty in the estimates of O&M costs for both the new construction and renovation alternatives. We want to do a general sensitivity analysis, but will only consider ranking reversals for changes in the cost estimates of 25 to 75 percent.

The method illustrated here is the one used in the ECONPACK program.

First, set up the alternatives' NPV equations with X_N representing the percentage change in the new construction alternative's O&M cost and X_R representing the percentage change in the renovation alternative's O&M cost:

$$NPV_{NEW} = \$1,000,000(0.953) + \$20,000(8.655)(1 + X_N) - \$300,000(0.084)$$

$$= \$1,100,900 + \$173,100X_N$$

$$NPV_{REN} = \$700,000(0.953) + \$30,000(8.655)(1 + X_R) + \$70,000(0.489) + \$80,000(0.304)$$

$$= \$985,300 + \$259,650X_R$$

Equating these--

$$\$985,300 + \$259,650X_R = \$1,100,900 + \$173,100X_N$$

$$\$259,650X_R = \$115,600 + 173,100X_N$$

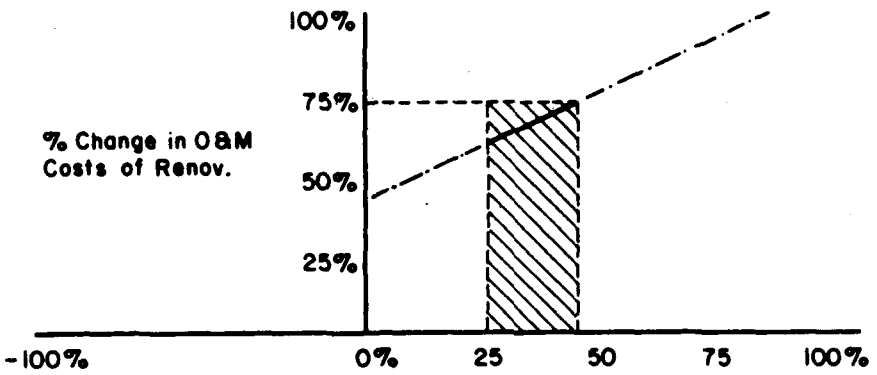
$$X_R = 0.4452 + 0.6667X_N$$

This equation represents all values of percentage change in O&M costs of the two alternatives for which the NPVs are equal.

For example, if the new alternative's O&M cost increases 10 percent (i.e., $X_N = 0.10$), then a change of 0.4452 + 0.06667 = 0.512 or 51.2 percent in X_R would make the NPV of the renovation alternative equal to that of the new construction alternative.

Figure 6-6. Example of sensitivity analysis with uncertainties in cost for both alternatives.

The equation is a straight line and can be graphed as shown below:



For the range of uncertainties, 25 to 75 percent, in the O&M costs of each alternative, the points on the line in the shaded area represent the solution to the equation. Values for percentage change in O&M costs for each alternative to make their NPVs equal were calculated by ECONPACK and are:

% Change in O&M costs for renovation	% Change in O&M costs for new constr.	Net present value ($)
45.9	2.0	1,104,846
47.9	5.0	1,110,039
49.9	8.0	1,115,232
51.9	11.0	1,120,425
53.9	14.0	1,125,617
55.9	17.0	1,130,810
57.9	20.0	1,136,003
59.9	23.0	1,141,196
61.9	26.0	1,146,389
63.9	29.0	1,151,581
65.9	32.0	1,156,774
67.9	35.0	1,161,967
69.9	38.0	1,167,160
71.9	41.0	1,172,353
73.9	44.0	1,177,545
75.9	45.6	1,180,347

Figure 6-6. (Cont'd).

7 COMMERCIALLY FINANCED FACILITIES: ECONOMIC ANALYSIS WHEN LEASING IS AN OPTION

7-1. General

CFF is an alternate method of providing facilities and services using the private sector as the primary source for financing. The CFF concept is relatively straightforward; the Government enters into a long-term contract for the provision of a facility where the Army is the principal customer for the services provided within that facility. Ultimately, the Army seeks to obtain a package of services from the private sector at a lower cost than through the traditional MILCON acquisition process. The package of services usually includes the financing, design, construction, operation and maintenance of the facility over a 20- to 32-year period. The facilities generally do not belong to the Government at the end of the contract term. CFF offers opportunities for the Army to acquire needed facilities which would not successfully compete in the traditional financing arenas due to present budgetary restrictions and the higher priority of other Army requirements.

Separate Legislative Authorities govern different MILCON programs (MCA, AFH, Energy) and allow for CFF initiatives.

7-2. Overview of lease contract EAs for Army facilities

a. Title 10 of the United States Code authorizes lease/contracts for five types of facilities under five sections of the code:

(1) Section 2667. Land Leases.

(2) Section 2394. Energy or Fuel Contracts.

(3) Section 2809. Long Term Facilities Contracts.

(4) Section 2821. Army Family Housing Rental Guarantee 802 Housing.

(5) Section 2828. Army Family Housing Build to Lease 801 Housing.

b. In addition, special congressional legislation can provide authorizations for specific projects.

c. CFF should not be confused with "Contracting out." The A-76 Program (OMB Circular as implemented in 1955 and revised in 1983) requires federal agencies to conduct cost comparisons between an in-house work force or internal supplier and a commercial activity. The A-76 Program is applied to service contracts specifically whereas CFF provides for both facilities and services.

d. Leasing is another method for acquiring facilities distinct from CFF. Leasing is generally used for requirements which have a limited duration or a special, unusual purpose. The General Services Administration (GSA) is responsible for leases of general purpose space under geographic jurisdiction of GSA. Under CFF, the Military Service (Army, Navy, Air Force), not GSA, is responsible for selecting, reviewing and submitting the CFF projects to Congress for approval.

7-3. Request for Proposal

Obtaining facilities and/or services under lease contract authority involves the formation of a contract. The Request for Proposal (RFP) is the type of contracting document used by the Government to identify the technical requirements, bid schedule, and evaluation process. In response to an RFP, proposals are subsequently submitted by developers with proposed cost, technical data, and management plans. The Government evaluates proposals received from developers, conducts negotiations, and awards a contract. The RFP is a critical component of the CFF process. The RFP defines precisely and clearly the obligations of the Government and the developer with respect to the project. The RFP is the framework from which a comprehensive EA is developed. Cost and contract terms, as specified in the RFP, must be reflected in the EA. For example, the RFP may specify a fixed rental charge to the Government, not subject to price escalation (inflation). The EA should then reflect a fixed rental cost throughout the contract term. The RFP may specify Government responsibility for support services, such as O&M to the facility or Government payment of all tax and insurance increases. The EA and RFP are interrelated documents and a complete and accurate EA cannot be developed in isolation. The provisions of the RFP are the basis for types of costs included in the EA. It is important to develop an EA that reflects the provision of the RFP.

7-4. Application of OMB Circular A-104

OMB Circular A-104 is the regulation for EA when leasing is an option. This document must be used when the assets to be leased have a total fair market value exceeding $1 million. It is optional for use when lesser dollar values are involved. It does not apply to service contracts. That is, service contracts that involve the use of capital assets by the contractor incidental to the provision of services to the Government are analyzed under OMB Circular A-76.

a. The lease-versus-buy analysis required by OMB Circular A-104 is intended to determine if it would cost less to lease or to buy a given asset. It is not to be used to determine what kind of asset should be acquired, in what amount, or on what acquisition schedule. For example, when a choice between leasing an asset this year and purchasing it next year is involved, a cost-benefit analysis to determine when to acquire the asset is conducted first, then the lease-versus-buy analysis is performed to determine whether to lease or buy.

b. OMB Circular A-104 introduces a departure from traditional (nonlease) EA methods. These differences are discussed in paragraphs 7-5 through 7-11 below.

7-5. Analytical perspective

In the traditional (nonlease) Army EA, the perspective taken by the analyst is that of evaluating costs to the Army of the various alternatives. In EAs with lease alternatives, the cost is considered as the cost to the Government as a whole. This means that in addition to lease or acquisition costs, costs to the Government in areas such as special tax and accelerated depreciation plans must be included. Note that the normal income tax payment is not included (see para 7-9).

7-6. Method of comparing alternatives

The basis for comparing alternatives is the NPV method. Other methods, such as SIR and DPP, are not to be used.

7-7. Inflation

All costs are expressed in current ("then year") dollars (taking into account price escalations). Costs are discounted back to a common year, usually the year in which the lease will begin. Because all costs are expressed in current year dollars, the analyst must use inflation rates to escalate the costs. The best estimates of inflation rates are the DOD escalation rates given in the Army Program and Budget Committee report. These are also available in "ECON BRIEFS," a file that can be accessed on the PAX ECONPACK program by use of the Help prompt. These tables provide the price escalation rates by type of appropriation, whether it is MCA or OMA. However, they provide a forecast for only the first 6 years, after which the rate is constant. To provide a more realistic rate for the outyears, a rate from a long-range econometrics firm can be used. A sensitivity test can be performed to evaluate the effects of varying rates.

7-8. Discount rate

The discount rate in lease-versus-buy options differs in several ways from those in the nonlease economic analysis.

a. The discount rate for lease-versus-buy analyses is the current interest rate on new issues of U.S. Treasury securities with maturities most nearly equal to the term of the lease. These rates are given in the Statistical Release (called H-15) published weekly by the Board of Governors of the Federal Reserve Center, Washington, DC. The rate corresponding to an issue with the number of years equal to or greater than the period of analysis is appropriate. Then 1/8 percent is added to this rate to obtain the rate to be used in the analysis. This addition reflects the Treasury charge for agency borrowings.

b. Either mid-year (or continuous) or end-of-year discount factors should be used, as appropriate.

c. Because the Treasury borrowing fluctuates over time, it might change significantly from the time the analysis is performed until the final decision is made. Thus, it is very important to perform a sensitivity analysis with the discount rate varied $\pm$25 percent. For example, if the forecast rate from H-15 is 8 percent, the rate to be used in the analysis is 8 1/8 percent and in the sensitivity analysis it should be varied from 0.75(8.125 percent) to 1.25(8.125 percent) or 6.1 percent to 10.2 percent. In the report, sensitivity analysis results are reported in a "what-if" sense. That is, they do not invalidate the analysis results, but simply show how results may change if the discount rate changes. The ECONPACK program has a feature to perform this sensitivity analysis.

7-9. Tax implications

The normal payment of taxes refers to the income tax effects on the U.S. Treasury, produced by a given expenditure.

a. Every dollar spent by the Government, regardless of whether it pays for a facility, a service, or some other commodity, and regardless of whether the payment goes to a contractor or to an in-house workforce, becomes the income of some taxable party.

(1) For example, if the Government pays $100 for a maintenance facility to a contractor (third-party contracting), $25 might go to a developer to construct the facility, $30 to the employees the contractor provides, $15 to pay the contractor's utility expenses to operate the facility, $15 to purchase supplies, equipment, and other overhead, and $15 would be counted as profit. Each of these expenses is subject to being taxed (see para b below); employees pay personal income tax, suppliers are taxed on the revenue generated by the purchase of their goods, profits are assessed corporate income taxes, and so on.

(2) Similarly, $100 paid for a Government-operated/MILCON maintenance facility would be divided among facility costs, in-house employee salaries, overhead, supplies, and other expenses. The entire $100 that pays for the maintenance facility and its operation becomes some other party's income and, therefore, will be taxed (see para b below). In either situation, third-party or in-house operated MILCON, the $100 will be fully taxed.

b. The rates of taxation for the various types of income tax are assumed roughly equal to avoid the complexities in trying to determine the actual rate of taxation on all assets and services and at all of the different levels in the spending-income chain. It should be noted that typical Government cost-benefit and economic analyses use pre-tax values of expenditures for the reasons just mentioned.

c. OMB Circular A-104 states correctly: "The normal payment of taxes on income and profits by the lessor (or by other parties to the transaction) should not be included in the lease-versus-buy analysis. Normal income taxes are already taken into account when the cost of obtaining assets is measured by their market prices; including them explicitly in the analysis would represent double counting."

7-10. Imputed costs

In an EA governed by OMB Circular A-104, insurance premiums, land costs and real estate taxes must be considered. These are not absolute values like operations or lease payments, but must be estimated and imputed. They are usually difficult to determine since the Government does not normally pay these costs directly. Since a private developer pays insurance, real estate taxes, and land purchase costs, these costs are reflected in the lease charge to the Government and must therefore be imputed for the Government so the alternatives are comparable.

a. Imputed cost of land. This cost is the Government's lost revenue in retaining property that might otherwise be sold on the private market or used for another purpose. This cost repesents an "opportunity cost" to the Government which is involved with holding the property. This value would be realized if the land were sold. To estimate the imputed cost and include it in the purchase alternative, an equivalent cost must be found in the private market. However, if the leased facility is to be located onpost, the land cost is a wash and need not be considered.

(1) To obtain a reasonable equivalent cost, the analyst must find the most recent transaction for a piece of property similar to the one being held. This figure

should be for a recent sale in the same general area for land with similar attributes, such as nearness to services and population centers. In addition, some consideration should be given to any zoning that would apply if the land were a private holding. This represents the best estimate of the market value of the land and should be imputed to the Government alternative of the EA.

(2) It may be possible to obtain this information from local real estate dealers or from records of recent transactions. However, the agency that handles the installation real estate transactions is normally the best source. This could be the real estate office on the installation or one at the district office.

b. Imputed insurance. The Government is normally "self-insured." For this analysis, an estimate is needed for the insurance premium against loss of property of the type in the EA. To determine the value of the insured property, the analyst must establish some equivalent commercial value for the building. The approach should be the same as that for the imputed cost of land. The annual imputed cost of insurance can then be computed as a fixed fractional share of the value of the property. The fractional share can be derived from rate schedules of commercial insurers. Per OMB Circular A-104, local estimates of standard commercial coverage for similar property may also be obtained from the Building Owners and Managers Association (BOMA) Regional Exchange reports. In some leases, the Government may pay the insurance costs. The EA must reflect any such special provisions such as this.

c. Imputed real estate taxes. Imputed real estate taxes must be added to the Government MILCON alternative. The analyst should consult the city or county office of assessments to obtain the method of assessment (say 30 percent of market value) and the tax rate to be applied (such as 1.5 percent). Then the yearly tax would be calculated and used as the Government's expense for providing community-type services. Normally the cost of real estate taxes is included in the lease charges to the Government. However, the lease contract may specify that the Government will pay any increase in property taxes charged to the private developer. The EA must reflect any such special provision in the lease contract.

7-11. Exchange rates

The use of foreign currency rates is a problem unique to analyses performed on overseas projects where costs are stated in foreign currencies. It is difficult to obtain reliable forecasts of outyear foreign exchange rates. One approach is to apply the concept of "purchasing power parity." This approach assumes that if local inflation is greater than U.S. inflation, the rise in local currency will be fully offset by dollar depreciation. Under this approach, it is possible to reflect the long-term dollar costs without resorting to a commercial forecast of the exchange rate and local inflation rate. This process is outlined below.

a. If costs are first expressed in constant terms, note the base year. If costs are first expressed in current terms, deflate by using a compound index on whatever local inflation estimates were used in estimating current costs. The result of this step is costs expressed in constant terms for a known base year.

b. Multiply the result from step a by the dollar/foreign currency exchange rate for the known base year. The result of this step is the constant dollar costs.

c. With the constant dollar costs now established, these values need to be multiplied by the U.S. compound inflation values using the base year established at step a. These will be the outyear costs for the economic analysis.

7-12. Section 2809. Long-Term Facilities Contracts

a. Section 2809 is the CFF authority appropriate for the category of MCA projects. Section 2809 will be described in detail since it is the approved legislation for MCA program application. The six facilities categories eligible for CFF are identified below.

(1) Child care services.

(2) Potable and wastewater treatment services.

(3) Depot supply activities.

(4) Troop housing.

(5) Transient quarters.

(6) Other logistic and administrative services (other than depot maintenance).

b. An explanation of Section 2809 is as follows. "The Secretary concerned may enter into contracts for the construction, management and operation of a facility on or near a military installation for the provision of an activity or service [when] the Secretary concerned has identified the proposed project in the budget proposal to Congress and has determined that the facility can be more economically provided under a long-term contract than by conventional means." The main points are--

(1) It can be on-post or near. "Near" has not been defined quantitatively and depends on the particular project, installation, and operational requirements. A rule of thumb to follow is 200 miles or less.

(2) A contract under this section may be for "any period not in excess of 32 years, excluding the period of construction."

(3) The contract provides for the "construction, operation, and management of a facility" by a developer. Ownership does not reside with the Government. The 2809 authority allows for the developer to restore the site to its original condition at the end of the 32-year contract or abandon the structures in place. Options to either extend the contract or purchase the facility at fair market value can be included in the Request for Proposal (RFP) but are subject to authority of Congress to allow this.

(4) Construction of a free-standing facility is required. Renovation or an addition to an existing facility is not acceptable.

(5) The Service secretary, as opposed to the Secretary of Defense (OSD) may select and enter into lease/contracts after Congressional approval. The Assistant Secretary of the Army for Installations and Logistics (ASA I&L) is the proponent for 2809 projects. Within Headquarters, U.S. Army Corps of Engineers (HQUSACE), the Directorate of Engineering and Construction (E&C) is responsible for the coordination and execution of 2809 candidate projects.

(6) An economic analysis must be submitted to Congress which demonstrates that lease/contract is more economical than nonlease options. The EA plays a central role in this process. It will serve as the basis on which Congress makes its ultimate decision.

c. Section 2809 is a test program. Success of the Services' test projects under this authority will directly influence its extension.

7-13. Section 2828. Army Family Housing Build to Lease 801 Housing

Section 801 is based on a traditional "Build to Lease" concept and allows DOD to lease housing and supporting community facilities on or near a military installation in the United States, Guam, or Puerto Rico. Under this program, DOD leases a housing project built specifically for military use for a period not to exceed 20 years, excluding the construction period.

Major provisions of the 801 program are as follows:

- The Government is responsible for performing the maintenance and paying property tax and insurance increases.
- All new 801 projects will be developed on private land. In some cases the Government may take an option on a private land parcel and turn the parcel over to the developer with the best proposal.
- Occupants forfeit Basic Allowances for Quarters (BAQ) and Variable Housing Allowances (VHA) in return for assigned quarters.
- The Government pays all rent, utilities and administrative costs.
- The new housing units are required to be constructed in conformance with DOD specifications.
- A validated deficit in military housing must exist in the general area.
- Upon termination of the lease agreement, the Government has the first right of refusal to acquire all right, title, and interest in the leased housing facilities.

The Section 801 Family Housing legislation requires the submission of an economic analysis to Congress for a 21 day review period showing that the proposed 801 lease is less expensive than military construction. The economic analysis is to be conducted in accordance with OMB Circular A-104. The 801 Legislation also requires that all contracts be publicly bid or negotiated. The format for the 801 solicitations is contained in a set of standard Request for Proposals (RFPs) developed by DOD. An example 801 economic analysis and narrative justification in the Congressional/OMB approved format, and a standard RFP package is available from HQUSACE, CERE/AM.

7-14. Section 2821. Army Family Housing Rental Guarantee 802 Housing

Section 802, commonly referred to as the "Rental Guarantee Program" authorizes negotiations with the private sector to provide new rental housing. The Government guarantees 97 percent occupancy. Unlike the 801 Program, the Service member rents

housing directly from the developer and continues to receive BAQ and VHA. Major provisions of the 802 Program are as follows:

- The Army guarantees 97 percent occupancy with service members leasing directly from the developers.
- Occupants continue to receive BAQ and VHA.
- Occupants pay for all rent and utilities.
- Rental rates may not exceed prevailing existing rates for comparable housing units in the same market area.
- New units must be constructed to DOD specifications.
- This program may not be applied to existing housing.
- The leasing arrangements may not exceed 25 years.
- A validated deficit in military housing must exist in the general area.
- Use of military controlled housing must have exceeded 97 percent occupancy 18 consecutive months preceding an agreement.
- Priority shall be given to military families.
- The housing site may be on private or Government-owned land.

An economic analysis must be prepared demonstrating that leasing is more cost effective than other means of providing the housing units. The 802 guarantee may not be renewed unless the housing units are located on Government-owned land, in which case the renewal period may not exceed the original contract term.

8 ECONOMIC ANALYSIS REPORTING

8-1. Purpose of report

Upon completion of the EA, the results must be communicated to the decision-makers in an easily understood format. The report should contain summary data for the life-cycle cost analysis of each alternative, appropriate graphs, and summaries of any sensitivity analyses. In addition, it should present conclusions and recommendations. A complete report will contain all of these elements. The parts described in paragraphs 8-2 through 8-4 below are currently required in the DD Form 1391.

8-2. Executive summary

The first section of the report should be an executive summary. This section gives the objective, alternatives, ranking of alternatives, conclusions, and recommendations. It also lists any assumptions made for the analysis. It gives some details such as the discount rate, period of analysis, and start and base years.

8-3. Detailed life-cycle cost analysis

This section presents tables of detailed costs for each alternative in each year of the analysis. These tables show the occurrences and patterns of costs over time for each alternative. The sources and derivations for cost are also given in this section.

8-4. Graph of NPVs

A graph showing cumulative NPV for each alternative over time should be included.

8-5. Sensitivity analysis

This section should begin with a paragraph discussing which costs need to be examined in sensitivity analyses. Then results of varying these costs--effects on the alternatives' rankings--are given.

8-6. Report review

Appendix D is a guide for reviewing the EA. It can be used as a checklist for both preparers and reviewers of analyses.

8-7. Examples

The examples in appendix E show typical EA reports as generated by ECONPACK. Once these are generated on the PAX ECONPACK program, the executive summary, life-cycle cost analysis and graph can be transferred to the DD Form 1391, Special Requirements Paragraph 1. If an EA is not generated on ECONPACK, results should be reported as described above. Formats for presenting results should be as shown in the reports for the examples of appendix E.

APPENDIX A:

REFERENCES

AR 1-1
Planning, Programming, and Budgeting Within the Department of the Army

AR 5-4
Department of the Army Productivity Improvement Program (DAMRIP)

AR 5-20
Commercial Activities Program

AR 11-18
The Cost Analysis Program

AR 11-28
Economic Analysis and Program Evaluation for Resource Management

AR 37-100
Account/Code Structure

AR 415-15
Military Construction, Army (MCA) Program Development

AR 415-17
Cost Estimating for Military Programming

DA Pam 11-5
Standards for Presentation and Documentation of Life Cost Estimates for Army Material Systems

DA Pam 210-6
Economic Analysis of Army Housing Alternatives - Concepts, Guidelines and Formats

Grant, E. L., and W.G. Ireson, *Principles of Engineering Economy*, 5th ed., Ronald Press, 1970.

NAVFAC P-442
Economic Analysis Handbook

OMB Circular A-76
Policies for Acquiring Commercial or Industrial Products and Services for Government Use

OMB Circular A-94
Discount Rates to be Used in Evaluating Time-Distributed Costs and Benefits

OMB Circular A-104
Evaluating Leases of Capital Assets

APPENDIX B:

PRESENT VALUE FACTORS

Table B-1 gives end-of-year and mid-year discount factors for a 10 percent discount rate for 30 years. Both the single and cumulative uniform series amounts are given. The formula used for calculating the single amount factors is--

$$\frac{1}{(1.10)^n}$$

where n = the year. For end-of-year factors, n = 1, 2, etc., whereas for mid-year factors, n = 0.5, 1.5, 2.5, etc., for years 1, 2, and 3, respectively.

Table B-1. Discount factors for a 10 percent rate

Year	End-of-Year		Mid-Year	
	Single Amount*	Cumulative Unif. Ser. Amt.**	Single Amount*	Cumulative Unif. Ser. Amt.**
1	0.909	0.909	0.953	0.953
2	0.826	1.736	0.867	1.820
3	0.751	2.487	0.788	2.608
4	0.683	3.170	0.716	3.325
5	0.621	3.791	0.651	3.976
6	0.564	4.355	0.592	4.568
7	0.513	4.868	0.538	5.106
8	0.466	5.335	0.489	5.595
9	0.424	5.759	0.445	6.040
10	0.386	6.145	0.404	6.444
11	0.350	6.495	0.368	6.812
12	0.319	6.814	0.334	7.146
13	0.290	7.103	0.304	7.450
14	0.263	7.367	0.276	7.726
15	0.239	7.606	0.251	7.977
16	0.218	7.824	0.228	8.206
17	0.198	8.022	0.208	8.413
18	0.180	8.201	0.189	8.602
19	0.164	8.365	0.171	8.773
20	0.149	8.514	0.156	8.929
21	0.135	8.649	0.142	9.071
22	0.123	8.772	0.129	9.200
23	0.112	8.883	0.117	9.317
24	0.102	8.985	0.106	9.423
25	0.092	9.077	0.097	9.520
26	0.084	9.161	0.088	9.608
27	0.076	9.237	0.080	9.688
28	0.069	9.307	0.073	9.761
29	0.063	9.370	0.066	9.827
30	0.057	9.427	0.060	9.887

*The single amount is for use with a single cost in 1 year.
**The uniform series amount is for use when the same cost occurs each year.

APPENDIX C:

ESTIMATING RESIDUAL VALUES

In new construction and some leasing alternatives, estimates of the residual value for each year of the analysis may be needed. The final residual or terminal value is always required. Table C-1 lists building decay-obsolescence and site appreciation (land) factors that can be used to determine values at any point in time. These factors are for general use. The analyst may develop such factors for a particular analysis applicable to the local situation, but should document the rationale behind them in the report.

Table C-1. Building decay-obsolescence and site appreciation factors

Period of Analysis	Building Decay-Obsolesence Factors*	Site Appreciation Factors*
1	0.98300	1.01500
2	0.96629	1.03023
3	0.94986	1.04568
4	0.93371	1.06136
5	0.91784	1.07728
6	0.90224	1.09344
7	0.88690	1.10984
8	0.87182	1.12649
9	0.85700	1.14339
10	0.84243	1.16054
11	0.82811	1.17795
12	0.81403	1.19562
13	0.80019	1.21355
14	0.78659	1.23176
15	0.77322	1.25023
16	0.76007	1.26899
17	0.74715	1.28802
18	0.73445	1.30734
19	0.72197	1.32695
20	0.70969	1.34686
21	0.69763	1.36706
22	0.68577	1.38756
23	0.67411	1.40838
24	0.66265	1.42950
25	0.65139	1.45095
26	0.64031	1.47271
27	0.62943	1.49480
28	0.61873	1.51722
29	0.60821	1.53998
30	0.59787	1.56308

*The factors assume end-of-year building decay-obsolescence and site appreciation changes.

APPENDIX D:

GUIDELINES FOR REVIEWING ECONOMIC ANALYSES

D-1. General

The following checklist will be of use to both analysts and reviewers to ensure that an EA is complete, correct, and well documented. Once the analysis has been reviewed, decision-makers should be able to accept the results and use them in their decision process.

D-2. Objective, assumptions and alternatives

a. Is the problem, as stated, the real problem?

b. Is the objective, as stated, unbiased as to the means of meeting the objective?

c. Are any reasonable alternatives left out of the analysis without an explanation?

d. Are assumptions--

(1) Too restrictive (e.g., do not allow an alternative to be considered)?

(2) Too broad (e.g., there will always be a requirement for a certain type facility)?

(3) Too vague to apply to the problem being studied?

e. Are uncertainties treated as facts? Can facts be verified?

f. Are potential mission change constraints on the economic life of an alternative given due consideration? Has the impact of technological change been fully considered?

g. Are any feasible alternatives omitted and, if so, are the reasons explained?

h. Are the alternatives well defined and discrete (do not overlap)?

D-3. Cost estimates

a. Are the cost-estimating methods used obvious or, if not, explained? Are they appropriate?

b. Are all relevant costs included?

c. Are sunk costs properly excluded?

d. Are the sources of the cost data given? Are these sources accurate and applicable?

e. Have all cost estimates been made in the proper type dollars--base year constant dollars for the normal analysis and current year dollars for an analysis with a lease alternative? Is the source of inflation indices given?

f. If parametric cost estimating was used, are the cost estimating relationships statistically/mathematically valid? Are the estimates interpolated within the range of historical data or has extrapolation been used?

g. Have terminal or residual values been included properly? Is the residual schedule appropriate?

D-4. Benefits

a. Should the analysis consider benefits other than the normal case where all alternatives give comparable benefits? Does the analysis ignore some part of total output?

b. Are the criteria used to measure a benefit defendable?

c. Is a benefit, in fact, unmeasurable? Is there a rational assessment of nonquantifiable factors?

d. If savings have been claimed, will a budget actually be reduced?

e. Have cost reductions been excluded from the benefit list to avoid double counting?

f. Have cost avoidances been considered?

g. Have all advantages and disadvantages of the alternatives been identified?

h. If an efficiency/productivity increase is projected, is there a documented need for greater output? If not, what is the impact on personnel requirements?

D-5. Time-dependent considerations

a. Was any lead time between the investment and the start of economic life included?

b. Was the present value analysis performed correctly? Was the proper discount rate used?

c. Are the economic lives used reasonable and sources given?

d. Is terminal value important in this analysis? If so, is it defendable?

e. If differential escalation has been assumed for a cost element, is there adequate justification?

f. If lead time differs among alternatives, have the economic lives been aligned?

D-6. Sensitivity analysis

a. If differential escalation was assumed, has a baseline analysis with no assumption of differential escalation been performed?

b. If the analysis includes a lease alternative, was the proper discount rate used (based on treasury securities) and was a sensitivity performed on this rate?

c. Have sensitivity analyses been performed to examine effects of changes in dominant cost elements, economic life, etc.? If not, is the reason correct?

d. Have all relevant "what-if" questions been answered?

e. Have the results of sensitivity analyses been discussed and incorporated in the report?

D-7. Recommendation of report

a. Is the selected alternative the logical result of the analysis ranking and sensitivity analyses? If not, are the reasons for its selection justifiable?

b. Is the selected alternative feasible in the real world of political, cultural, and policy consideration?

c. Is the recommendation based on significant differences between the alternatives?

d. Does the selection make sense intuitively?

APPENDIX E:

SAMPLE COMPUTER OUTPUTS FROM ECONPACK

E-1. Example secondary analysis

Example E1 is a MILCON secondary analysis called Fort Alice.

E-2. Example primary analysis

Example E2 is for a primary analysis called Tobyhanna.

E-3. Example analysis with lease option

Example E3 is for an analysis (called Panama) that includes a lease alternative.

Example E1.

Description

There is a requirement to provide 95,000 square feet of unaccompanied officer housing for a period of 25 years. This is a new requirement.

There are two alternatives, modification to existing space or new construction. The economic lives of the alternatives are 25 years. (Two other alternatives were considered---BAQ/VHA and Lease---but neither was considered feasible.)

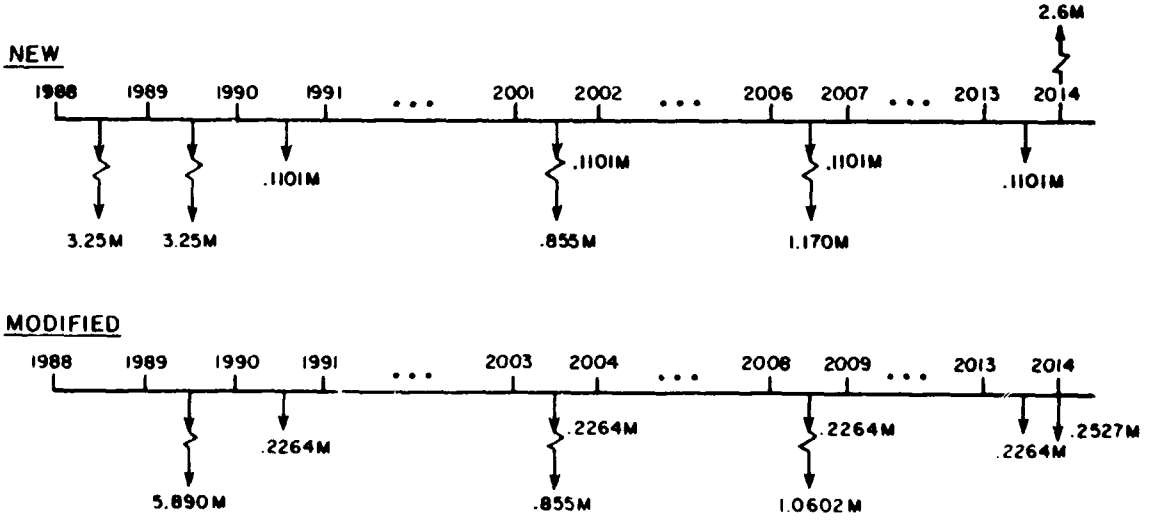
Beneficial occupancy will be in 1990. The start year and base year is 1988.

New construction data:

Construction costs = $68.42/sf
Annual maintenance/repair costs = $.54/sf in FY 86 dollars
Utility costs = $.53/sf
Roof replacement in year 15 with cost = $9.00/sf
HVAC replacement in year 20 with cost = 18% of initial construction costs
Residual value = 40% of initial construction costs

Modification data:

Renovation costs = $62.00/sf
Annual maintenance/repair costs = $1.30/sf
Utilities costs = $.87/sf
Roof replacement in year 15 = $9.00/sf
HVAC overhaul in year 20 = 18% of renovation costs
There is a demolition cost of $2.66/sf at the end of 25 years occupancy.



Discussion of results

The executive summary is printed first. It includes a results and recommendations section.

The next section of the report is a graph of the NPVs of the alternatives.

The life cycle cost (LCC) report is next and lists all costs for each year by alternative. The percent of the total NPV of an alternative for each cost is listed at the end of each cost column. This shows quickly which costs have the most impact on the NPV of the alternative. The source and derivation of costs and benefits are given at the end of the LCC report (page 5).

The final section is the sensitivity analysis report.

E X E C U T I V E S U M M A R Y R E P O R T PAGE 001

PROJECT TITLE : OFFICERS QUARTERS
PROJECT OBJECTIVE : PROVIDE 95000 SF OF UNACCOMPANIED OFFICER HOUSNG
DISCOUNT RATE : 10.00%
PERIOD OF ANALYSIS: 27 YEARS
START YEAR : 1988
BASE YEAR : 1988

ASSUMPTIONS OF THE ANALYSIS:
Construction is assumed to take 2 years.

Renovation is expected to take only one year.

The housing is required in 1990.

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS:
New Construction- this alternative will provide the required 95,000 sf of unaccompanied officer housing.

Modification- an existing, unoccupied administrative facility will be renovated to provide the necessary 95,000 sf of housing for unaccompanied officers.

Status Quo Operations- this is a new mission requirement. There are no facilities available to accomodate this increase in troop strength.

Pay BAQ/VHA- this alternative was eliminated from further evaluation due to the absence of housing available in the vicinity of Fort Alice. The closest town is 87 miles away. Winter conditions preclude commuting from this distance for 4 months of the year. Most importantly, mission requirements, due to the early deployment requirement preclude this unit from being billeted off-post.

Lease- No existing facilities are available for lease within a 100 mile radius of the installation. The mission requirements of this unit (as discussed above) prevent this alternative from being feasible.

ALTERNATIVES COMPARED:

ALTERNATIVE NAME	NPV	EUAC
1 NEW CONSTRUCTION	$6,911,890	$748,264
2 MODIFICATION	$7,416,163	$802,856

RESULTS AND RECOMMENDATIONS:

The new construction alternative is the least cost alternative. A sensitivity analysis showed that it would take a decrease in the renovation cost of 9.8% or more to make the renovation alternative least cost.

Based on these facts and the other advantages listed below, it is recommended that the new construction alternative be used to fulfill the requirement.

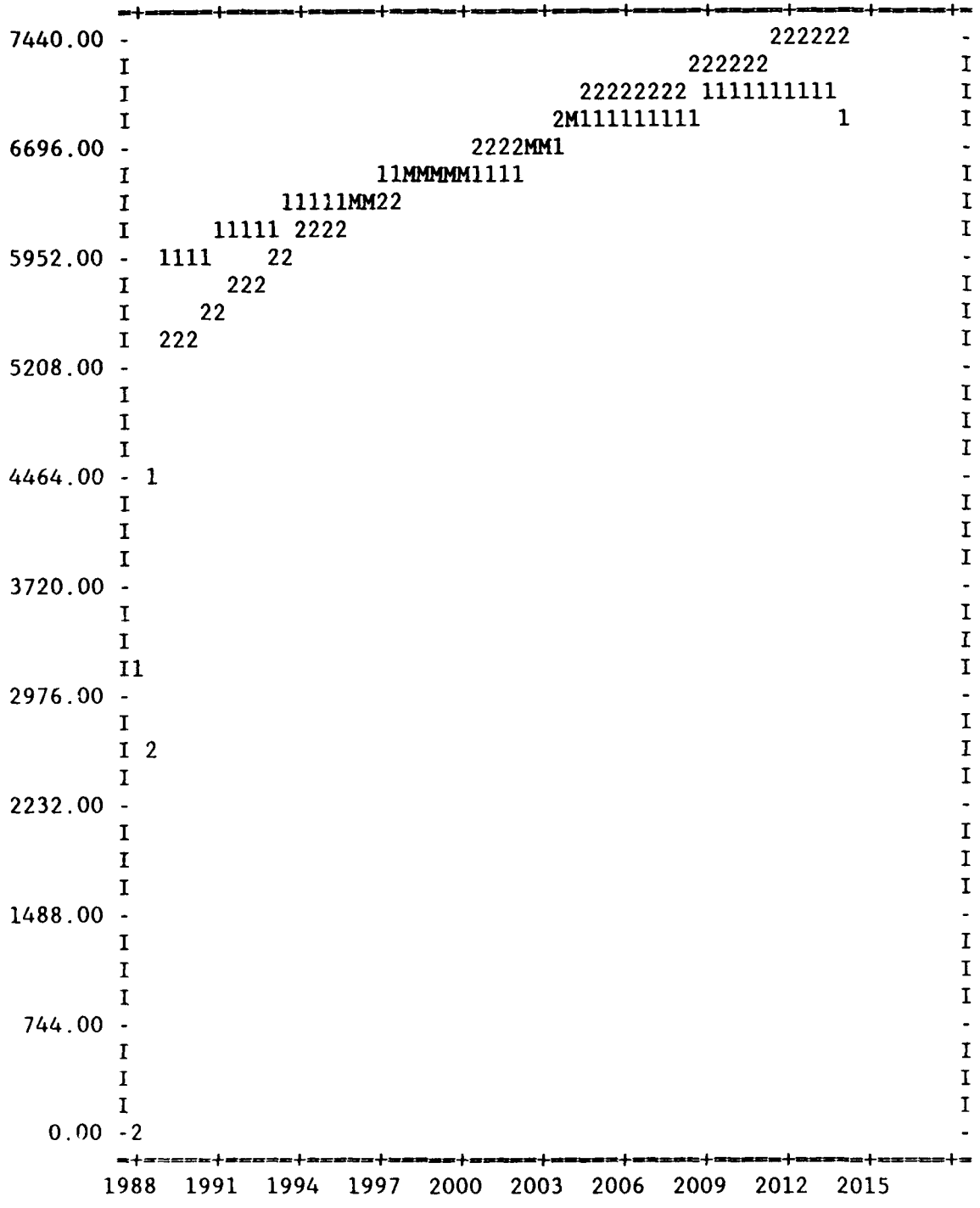
RESULTS AND RECOMMENDATIONS (cont.):
In addition to the quantitative advantages, the new construction alternative offers a higher ranking of non-monetary considerations as follows:

	Modification	New Construction
Morale	Fair	High
Discipline	Fair	Very Good
Re-enlistment	Fair	High
Readiness	Fair	Excellent
Traffic Accidents (lost time)	Fair	Excellent
Community Relations	Fair	Excellent

ACTION OFFICER: JAMES R. SPINDLE
ORGANIZATION : DEH, FORT ALICE

E C O N O M I C A N A L Y S I S G R A P H 1

CUMULATIVE NET PRESENT VALUE ($ in thousands)



FISCAL YEAR

LEGEND	DESCRIPTION
1	NEW CONSTRUCTION
2	MODIFICATION
M	MERGING DATA

L I F E C Y C L E C O S T R E P O R T

PROJECT/PROGRAM COSTS

ALTERNATIVE 1: NEW CONSTRUCTION

YEAR	INITIAL CONSTRUCTION COST (01)	MAINTENANCE AND REPAIR (02)	UTILITIES (03)	NEW ROOF IN YR 15 HVAC YR 20 (04)	TOTAL ANNUAL OUTLAYS
1988	$3,250,000	$0	$0	$0	$3,250,000
1989	$3,250,000	$0	$0	$0	$3,250,000
1990	$0	$59,700	$50,400	$0	$110,100
1991	$0	$59,700	$50,400	$0	$110,100
1992	$0	$59,700	$50,400	$0	$110,100
1993	$0	$59,700	$50,400	$0	$110,100
1994	$0	$59,700	$50,400	$0	$110,100
1995	$0	$59,700	$50,400	$0	$110,100
1996	$0	$59,700	$50,400	$0	$110,100
1997	$0	$59,700	$50,400	$0	$110,100
1998	$0	$59,700	$50,400	$0	$110,100
1999	$0	$59,700	$50,400	$0	$110,100
2000	$0	$59,700	$50,400	$0	$110,100
2001	$0	$59,700	$50,400	$0	$110,100
2002	$0	$59,700	$50,400	$0	$110,100
2003	$0	$59,700	$50,400	$0	$110,100
2004	$0	$59,700	$50,400	$855,000	$965,100
2005	$0	$59,700	$50,400	$0	$110,100
2006	$0	$59,700	$50,400	$0	$110,100
2007	$0	$59,700	$50,400	$0	$110,100
2008	$0	$59,700	$50,400	$0	$110,100
2009	$0	$59,700	$50,400	$1,170,000	$1,280,100
2010	$0	$59,700	$50,400	$0	$110,100
2011	$0	$59,700	$50,400	$0	$110,100
2012	$0	$59,700	$50,400	$0	$110,100
2013	$0	$59,700	$50,400	$0	$110,100
2014	$0	$59,700	$50,400	$0	$110,100
%NPV	85.59	6.80	5.74	4.75	

PROJECT/PROGRAM COSTS

ALTERNATIVE 1: NEW CONSTRUCTION

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1988	$3,098,753	$3,098,753	$0	$3,098,753
1989	$2,817,049	$5,915,802	$0	$5,915,802
1990	$86,757	$6,002,559	$0	$6,002,559
1991	$78,870	$6,081,429	$0	$6,081,429
1992	$71,700	$6,153,129	$0	$6,153,129
1993	$65,182	$6,218,311	$0	$6,218,311
1994	$59,257	$6,277,568	$0	$6,277,568
1995	$53,870	$6,331,438	$0	$6,331,438
1996	$48,972	$6,380,410	$0	$6,380,410
1997	$44,520	$6,424,930	$0	$6,424,930
1998	$40,473	$6,465,403	$0	$6,465,403
1999	$36,794	$6,502,197	$0	$6,502,197
2000	$33,449	$6,535,646	$0	$6,535,646
2001	$30,408	$6,566,054	$0	$6,566,054
2002	$27,643	$6,593,697	$0	$6,593,697
2003	$25,131	$6,618,828	$0	$6,618,828
2004	$200,260	$6,819,088	$0	$6,819,088
2005	$20,769	$6,839,857	$0	$6,839,857
2006	$18,881	$6,858,738	$0	$6,858,738
2007	$17,164	$6,875,902	$0	$6,875,902
2008	$15,604	$6,891,506	$0	$6,891,506
2009	$164,931	$7,056,437	$0	$7,056,437
2010	$12,896	$7,069,333	$0	$7,069,333
2011	$11,724	$7,081,057	$0	$7,081,057
2012	$10,658	$7,091,715	$0	$7,091,715
2013	$9,689	$7,101,404	$0	$7,101,404
2014	$8,808	$7,110,212	$198,322	$6,911,890
%NPV			-2.87	

EQUIVALENT UNIFORM ANNUAL COST = $748,264 (10.00% DISCOUNT RATE, 27 YEARS)

PROJECT/PROGRAM COSTS

ALTERNATIVE 2: MODIFICATION

YEAR	RENOVATION UPGRADE (01)	UPGRADE IN YEAR 15 ROOF YEAR 20 HVAC (02)	MAINTENANCE AND REPAIR (03)	UTILITIES (04)	TOTAL ANNUAL OUTLAYS
1988	$0	$0	$0	$0	$0
1989	$5,890,000	$0	$143,800	$82,600	$6,116,400
1990	$0	$0	$143,800	$82,600	$226,400
1991	$0	$0	$143,800	$82,600	$226,400
1992	$0	$0	$143,800	$82,600	$226,400
1993	$0	$0	$143,800	$82,600	$226,400
1994	$0	$0	$143,800	$82,600	$226,400
1995	$0	$0	$143,800	$82,600	$226,400
1996	$0	$0	$143,800	$82,600	$226,400
1997	$0	$0	$143,800	$82,600	$226,400
1998	$0	$0	$143,800	$82,600	$226,400
1999	$0	$0	$143,800	$82,600	$226,400
2000	$0	$0	$143,800	$82,600	$226,400
2001	$0	$0	$143,800	$82,600	$226,400
2002	$0	$0	$143,800	$82,600	$226,400
2003	$0	$0	$143,800	$82,600	$226,400
2004	$0	$855,000	$143,800	$82,600	$1,081,400
2005	$0	$0	$143,800	$82,600	$226,400
2006	$0	$0	$143,800	$82,600	$226,400
2007	$0	$0	$143,800	$82,600	$226,400
2008	$0	$0	$143,800	$82,600	$226,400
2009	$0	$1,060,200	$143,800	$82,600	$1,286,600
2010	$0	$0	$143,800	$82,600	$226,400
2011	$0	$0	$143,800	$82,600	$226,400
2012	$0	$0	$143,800	$82,600	$226,400
2013	$0	$0	$143,800	$82,600	$226,400
2014	$0	$0	$143,800	$82,600	$226,400
%NPV	68.84	4.23	16.94	9.73	

PROJECT/PROGRAM COSTS

ALTERNATIVE 2: MODIFICATION

YEAR	PRESENT VALUE	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1988	$0	$0	$0	$0
1989	$5,301,599	$5,301,599	$0	$5,301,599
1990	$178,400	$5,479,999	$0	$5,479,999
1991	$162,182	$5,642,181	$0	$5,642,181
1992	$147,438	$5,789,619	$0	$5,789,619
1993	$134,034	$5,923,653	$0	$5,923,653
1994	$121,850	$6,045,503	$0	$6,045,503
1995	$110,772	$6,156,275	$0	$6,156,275
1996	$100,702	$6,256,977	$0	$6,256,977
1997	$91,547	$6,348,524	$0	$6,348,524
1998	$83,225	$6,431,749	$0	$6,431,749
1999	$75,659	$6,507,408	$0	$6,507,408
2000	$68,781	$6,576,189	$0	$6,576,189
2001	$62,528	$6,638,717	$0	$6,638,717
2002	$56,844	$6,695,561	$0	$6,695,561
2003	$51,677	$6,747,238	$0	$6,747,238
2004	$224,393	$6,971,631	$0	$6,971,631
2005	$42,707	$7,014,338	$0	$7,014,338
2006	$38,825	$7,053,163	$0	$7,053,163
2007	$35,295	$7,088,458	$0	$7,088,458
2008	$32,087	$7,120,545	$0	$7,120,545
2009	$165,767	$7,286,312	$0	$7,286,312
2010	$26,518	$7,312,830	$0	$7,312,830
2011	$24,107	$7,336,937	$0	$7,336,937
2012	$21,916	$7,358,853	$0	$7,358,853
2013	$19,924	$7,378,777	$0	$7,378,777
2014	$18,112	$7,396,889	-$19,274	$7,416,163

%NPV			0.26	

EQUIVALENT UNIFORM ANNUAL COST = $802,856 (10.00% DISCOUNT RATE, 27 YEARS)

SOURCE AND DERIVATION OF COSTS AND BENEFITS:
All cost estimates were in 1988 dollars and rounded to the nearest $100.

NEW CONSTRUCTION
Initial construction cost - $68.42/sf per AR 415-17.
95,000sf x $68.42 = $6,500,000

Maintenance and repair cost estimates were obtained from FY86 Tech Data Reports. These costs were inflated to 1988 by DOD inflation indices as follows: $.54/sf x 95,000 sf = $51,300
$51,300 x 1.164 (Inflation) = $59,713 = $59,700.

Utility costs are based on DEH historical records @ $.53/sf
$.53/sf x 95,000 sf = $50,350 = $50,400.

Roof replacement and HVAC replacements were included in years 15 and 20 respectively. Roof estimates were developed as follows:
$9.00/sf x 95,000 sf = $855,000.
HVAC was assumed to be 18% of initial construction costs.
$6,500,00 x .18 = $1,170,000

A residual value for the facility was estimated to be 40% of initial construction costs. $6,500,000 x .40 = $2,600,000

MODIFICATION

Renovation costs - $62.00 per sf. x 95,000sf = $5,890,000

Maintenance and repair cost estimates were based on FY86 historical records and inflated to 1988: $1.30/sf x 95,000 sf = $123,500.
$123,500 x 1.164 (inflation) = $143,754 = $143,800.

Utilities cost estimates were also based on historical records as follows:
$.87/sf x 95,000 sf = $82,650 = $82,600.

A one-time upgrade in year 15 for the roof is estimated to cost
$9.00/sf x 95,000 sf = $855,000.

An upgrade of the HVAC system in year 20 is estimated to cost 18% of the renovation costs. $5,890,000 x .18 = $1,060,200.

Demolition costs for the facility were estimated to be $2.66/sf.
$2.66/sf x 95,000 sf = $252,700.

R A N K I N G S E N S I T I V I T Y A N A L Y S I S

SENSITIVITY ANALYSIS NUMBER 01
TITLE ..... TEST SENSITIVITY OF RENOVATION COSTS
ALLOWABLE CHANGE ..... 50.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 2 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
1	** NOTHING CHANGED **
2	1

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 50.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
1	$6,911,890
2	$7,416,163

FOR ALTERNATIVE 2 TO BE LEAST COST, REDUCE COSTS BY 9.88% OR MORE.

Example E2.

Description

There is a continuing requirement to maintain and store certain type shelters at the depot. Currently this is done in an open air environment, subject to weather conditions. This creates inefficiencies in the work and also increases deterioration of the shelters while in storage.

The work could be done better inside a building and storage in a building would elimimate the deterioration due to storage in an unprotected environment.

A primary analysis was performed to evaluate the cost savings resulting from construction of an environmentally controlled warehouse.

Current annual operating costs are $1,568,200.

New construction costs are estimated at $40.99/sf while operating and maintenance costs for a new facility would be $1.69/sf. The new facility would have a salvage value at the end of 25 years while there is none for the current operation.

Discussion of output

The format for the executive summary is the same as for a secondary analysis. However, the values of two other measures are also printed (SIR and DPP).

The graph format is also similar.

The life cycle cost (LCC) report provides the yearly cost data for each alternative; the format is similar to that in a secondary analysis. However, there is an additional table of comparison in the LCC report unique to a primary analysis (see pages 4-5).

At the end of the LCC report (page 6) the source and derivation of costs and benefits are given.

The final section gives results of the sensitivity analysis.

E X E C U T I V E S U M M A R Y R E P O R T PAGE 001

PROJECT TITLE : TOBYHANNA SHELTER MOVING STUDY
PROJECT OBJECTIVE : EVALUATE COST SAVINGS IN SHELTER MANIPULATIONS
DISCOUNT RATE : 10.00%
PERIOD OF ANALYSIS: 26 YEARS
START YEAR : 1988
BASE YEAR : 1988

ASSUMPTIONS OF THE ANALYSIS:
Construction time for a new facility is one year.

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS:
New construction - construct a new environmentally controlled 140,000sf facility.

Status quo - continue to maintain and store the shelters in an open environment.

ALTERNATIVES COMPARED:

ALTERNATIVE NAME	NPV	EUAC	SIR	DPP
1 STATUS QUO	$15,067,389	$1,644,741		
2 CONSTRUCT NEW FAC	$8,700,988	$949,791	1.96	6.9 YEARS

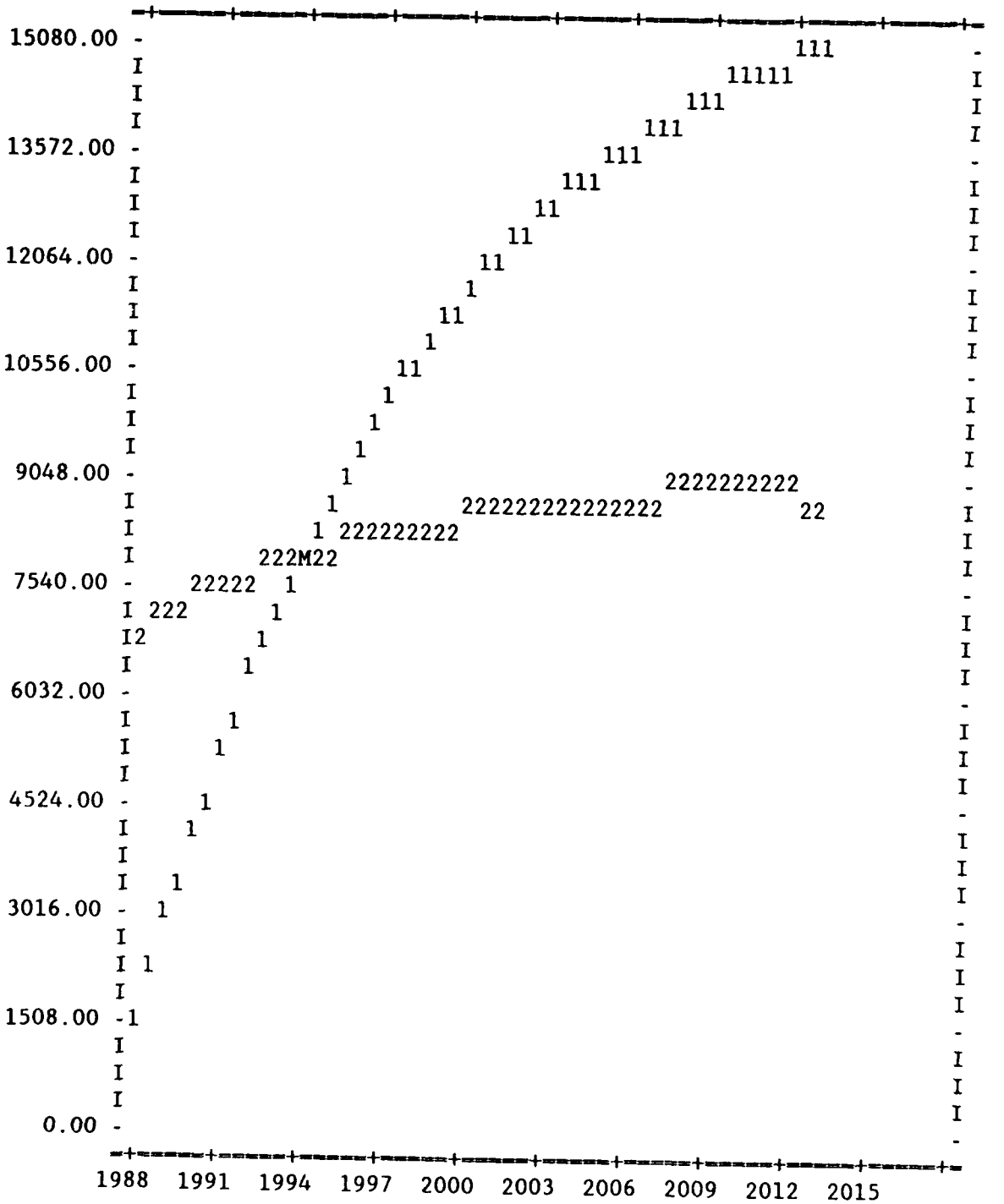
RESULTS AND RECOMMENDATIONS:
The proposed alternative results in a Savings-to-Investment of 2.0 and a discounted payback period of 7 years. A sensitivity analysis which allowed the operating costs of the proposed alternative to increase 50% was performed. The proposed alternative was still the least cost. It is recommended that the new warehouse be built.

ACTION OFFICER: BOB N
ORGANIZATION : USA-CERL

FILENAME: TOBYP3
13 NOV 1988

E C O N O M I C A N A L Y S I S G R A P H 1

CUMULATIVE NET PRESENT VALUE ($ in thousands)



FISCAL YEAR

LEGEND	DESCRIPTION
1	STATUS QUO
2	CONSTRUCT NEW FAC
M	MERGING DATA

L I F E C Y C L E C O S T R E P O R T

PROJECT/PROGRAM COSTS

ALTERNATIVE 1: STATUS QUO

YEAR	ANNUAL COSTS (01)	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1988	$1,568,200	$1,568,200	$1,495,220	$1,495,220
1989	$1,568,200	$1,568,200	$1,359,291	$2,854,511
1990	$1,568,200	$1,568,200	$1,235,719	$4,090,230
1991	$1,568,200	$1,568,200	$1,123,381	$5,213,611
1992	$1,568,200	$1,568,200	$1,021,255	$6,234,866
1993	$1,568,200	$1,568,200	$928,414	$7,163,280
1994	$1,568,200	$1,568,200	$844,013	$8,007,293
1995	$1,568,200	$1,568,200	$767,284	$8,774,577
1996	$1,568,200	$1,568,200	$697,531	$9,472,108
1997	$1,568,200	$1,568,200	$634,119	$10,106,227
1998	$1,568,200	$1,568,200	$576,472	$10,682,699
1999	$1,568,200	$1,568,200	$524,065	$11,206,764
2000	$1,568,200	$1,568,200	$476,423	$11,683,187
2001	$1,568,200	$1,568,200	$433,112	$12,116,299
2002	$1,568,200	$1,568,200	$393,738	$12,510,037
2003	$1,568,200	$1,568,200	$357,944	$12,867,981
2004	$1,568,200	$1,568,200	$325,403	$13,193,384
2005	$1,568,200	$1,568,200	$295,821	$13,489,205
2006	$1,568,200	$1,568,200	$268,928	$13,758,133
2007	$1,568,200	$1,568,200	$244,480	$14,002,613
2008	$1,568,200	$1,568,200	$222,255	$14,224,868
2009	$1,568,200	$1,568,200	$202,050	$14,426,918
2010	$1,568,200	$1,568,200	$183,682	$14,610,600
2011	$1,568,200	$1,568,200	$166,983	$14,777,583
2012	$1,568,200	$1,568,200	$151,803	$14,929,386
2013	$1,568,200	$1,568,200	$138,003	$15,067,389
%NPV	100.00			

EQUIVALENT UNIFORM ANNUAL COST = $1,644,741 (10.00% DISCOUNT RATE, 26 YEARS)

PROJECT/PROGRAM COSTS

ALTERNATIVE 2: CONSTRUCT NEW FAC

YEAR	CONSTRUCTION (01)	ANNUAL COSTS (02)	COST FOR CURRENT OPER DURING CONST (03)	TOTAL ANNUAL OUTLAYS	PRESENT VALUE
1988	$5,738,600	$0	$1,568,200	$7,306,800	$6,966,760
1989	$0	$236,600	$0	$236,600	$205,081
1990	$0	$236,600	$0	$236,600	$186,437
1991	$0	$236,600	$0	$236,600	$169,489
1992	$0	$236,600	$0	$236,600	$154,080
1993	$0	$236,600	$0	$236,600	$140,073
1994	$0	$236,600	$0	$236,600	$127,339
1995	$0	$236,600	$0	$236,600	$115,763
1996	$0	$236,600	$0	$236,600	$105,239
1997	$0	$236,600	$0	$236,600	$95,672
1998	$0	$236,600	$0	$236,600	$86,974
1999	$0	$236,600	$0	$236,600	$79,068
2000	$0	$236,600	$0	$236,600	$71,880
2001	$0	$236,600	$0	$236,600	$65,345
2002	$0	$236,600	$0	$236,600	$59,405
2003	$0	$236,600	$0	$236,600	$54,004
2004	$0	$236,600	$0	$236,600	$49,095
2005	$0	$236,600	$0	$236,600	$44,632
2006	$0	$236,600	$0	$236,600	$40,574
2007	$0	$236,600	$0	$236,600	$36,886
2008	$0	$236,600	$0	$236,600	$33,532
2009	$0	$236,600	$0	$236,600	$30,484
2010	$0	$236,600	$0	$236,600	$27,713
2011	$0	$236,600	$0	$236,600	$25,193
2012	$0	$236,600	$0	$236,600	$22,903
2013	$0	$236,600	$0	$236,600	$20,821
%NPV	62.88	23.53	17.18		

PROJECT/PROGRAM COSTS

ALTERNATIVE 2: CONSTRUCT NEW FAC

YEAR	CUMULATIVE PRESENT VALUE	PRESENT VALUE RESIDUAL	CUMULATIVE NET PRESENT VALUE
1988	$6,966,760	$0	$6,966,760
1989	$7,171,841	$0	$7,171,841
1990	$7,358,278	$0	$7,358,278
1991	$7,527,767	$0	$7,527,767
1992	$7,681,847	$0	$7,681,847
1993	$7,821,920	$0	$7,821,920
1994	$7,949,259	$0	$7,949,259
1995	$8,065,022	$0	$8,065,022
1996	$8,170,261	$0	$8,170,261
1997	$8,265,933	$0	$8,265,933
1998	$8,352,907	$0	$8,352,907
1999	$8,431,975	$0	$8,431,975
2000	$8,503,855	$0	$8,503,855
2001	$8,569,200	$0	$8,569,200
2002	$8,628,605	$0	$8,628,605
2003	$8,682,609	$0	$8,682,609
2004	$8,731,704	$0	$8,731,704
2005	$8,776,336	$0	$8,776,336
2006	$8,816,910	$0	$8,816,910
2007	$8,853,796	$0	$8,853,796
2008	$8,887,328	$0	$8,887,328
2009	$8,917,812	$0	$8,917,812
2010	$8,945,525	$0	$8,945,525
2011	$8,970,718	$0	$8,970,718
2012	$8,993,621	$0	$8,993,621
2013	$9,014,442	$313,454	$8,700,988
%NPV		-3.60	

EQUIVALENT UNIFORM ANNUAL COST = $949,791 (10.00% DISCOUNT RATE, 26 YEARS)

PRIMARY ECONOMIC ANALYSIS

PRESENT ALTERNATIVE: STATUS QUO
PROPOSED ALTERNATIVE: CONSTRUCT NEW FAC
ECONOMIC LIFE (PRESENT): 25 YEARS
ECONOMIC LIFE (PROPOSED): 25 YEARS

PROJECT YEAR(S)	RECURRING ANNUAL OPERATING COSTS PRESENT ALTERNATIVE	RECURRING ANNUAL OPERATING COSTS PROPOSED ALTERNATIVE	DIFFERENTIAL COST	PRESENT VALUE FACTOR	PRESENT VALUE OF DIFFERENTIAL COST
1988	$1,568,200	$0	$1,568,200	0.953	$1,495,220
1989	$1,568,200	$236,600	$1,331,600	0.867	$1,154,210
1990	$1,568,200	$236,600	$1,331,600	0.788	$1,049,282
1991	$1,568,200	$236,600	$1,331,600	0.716	$953,892
1992	$1,568,200	$236,600	$1,331,600	0.651	$867,175
1993	$1,568,200	$236,600	$1,331,600	0.592	$788,341
1994	$1,568,200	$236,600	$1,331,600	0.538	$716,674
1995	$1,568,200	$236,600	$1,331,600	0.489	$651,521
1996	$1,568,200	$236,600	$1,331,600	0.445	$592,292
1997	$1,568,200	$236,600	$1,331,600	0.404	$538,447
1998	$1,568,200	$236,600	$1,331,600	0.368	$489,498
1999	$1,568,200	$236,600	$1,331,600	0.334	$444,997
2000	$1,568,200	$236,600	$1,331,600	0.304	$404,543
2001	$1,568,200	$236,600	$1,331,600	0.276	$367,767
2002	$1,568,200	$236,600	$1,331,600	0.251	$334,333
2003	$1,568,200	$236,600	$1,331,600	0.228	$303,940
2004	$1,568,200	$236,600	$1,331,600	0.208	$276,308
2005	$1,568,200	$236,600	$1,331,600	0.189	$251,189
2006	$1,568,200	$236,600	$1,331,600	0.171	$228,354
2007	$1,568,200	$236,600	$1,331,600	0.156	$207,594
2008	$1,568,200	$236,600	$1,331,600	0.142	$188,723
2009	$1,568,200	$236,600	$1,331,600	0.129	$171,566
2010	$1,568,200	$236,600	$1,331,600	0.117	$155,969
2011	$1,568,200	$236,600	$1,331,600	0.106	$141,790
2012	$1,568,200	$236,600	$1,331,600	0.097	$128,900
2013	$1,568,200	$236,600	$1,331,600	0.088	$117,182
TOTALS	$40,773,200	$5,915,000	$34,858,200		$13,019,707

PRIMARY ECONOMIC ANALYSIS

TOTAL PRESENT VALUE OF NEW INVESTMENT	$6,966,760
PLUS: PRESENT VALUE OF EXISTING ASSETS TO BE USED	$0
LESS: PRESENT VALUE OF EXISTING ASSETS REPLACED	$0
LESS: PRESENT VALUE OF TERMINAL VALUE OF ALTERNATIVE	$313,454
TOTAL PRESENT VALUE OF NET INVESTMENT	$6,653,306
TOTAL PRESENT VALUE OF DIFFERENTIAL COSTS	$13,019,707
PLUS: PRESENT VALUE OF COST OF REFURBISHMENT OR MODIFICATION ELIMINATED	$0
LESS: STATUS QUO SALVAGE VALUE	$0
TOTAL PRESENT VALUE OF SAVINGS	$13,019,707
SAVINGS/INVESTMENT RATIO	1.96
DISCOUNTED PAYBACK PERIOD	6.9 YEARS

SOURCE AND DERIVATION OF COSTS AND BENEFITS:

NEW CONSTRUCTION

The construction cost for the new facility was obtained from the District office ($40.99/sf). 140,000 sf x $40.99/sf = $5,738,600.

Operating and maintenance costs were estimated at $1.69/sf based on historical data at the DEH office. 140,000 sf x $1.69/sf = $236,600.

Salvage value at the end of 25 years was based on the OMB Circular A-104 obsolescence factor:
$5,738,600 x .651 = $3,735,800.

CURRENT METHOD

The annual operating cost of $1,568,200 of the current method of operation was based on historical records for the past five years.

R A N K I N G S E N S I T I V I T Y A N A L Y S I S

SENSITIVITY ANALYSIS NUMBER 01
TITLE ..... Test of increase of operating costs of proposed alternative
ALLOWABLE CHANGE ..... 50.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 1 TO BE RANKED FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
1	** NOTHING CHANGED **
2	2

THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100% LESS THAN THEIR INPUT VALUE TO 50.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
2	$8,700,988
1	$15,067,389

INSENSITIVE WITHIN THE ALLOWABLE PERCENT OF CHANGE.

Example E3.

Description

Additional housing for 500 families for 15 years was required for an installation in the Panama Canal Zone.

Five alternatives were considered:

Lease through the Republic of Panama.

Build to lease.

Rental Guarantee

MCA construction

Purchase trailers/relocatable units

Since this secondary analysis has a lease as an option, OMB Circular A-104 guidelines must be followed. The ten year treasury rate was 8.60%. Sensitivity of results to a change in the discount rate must be tested.

Discussion of output

This EA is a secondary analysis and the format of the output is similar to that in Example E1.

First is the executive summary.

The graph of the NPVs of the alternatives is next.

The life cycle cost (LCC) report is next and shows all costs for each year for each alternative. The source and derivation of costs and benefits are given at the end of the LCC report (pages 11-12).

The sensitivity analysis report for varying costs is given next.

Since this EA has a lease, a sensitivity analysis on the discount rate was also performed and is given in the final section of the output. Two tables are given---a summary of how the rankings changed as the discount rate varied and a detailed one which lists the NPV for each alternative for each value of the discount rate over the range evaluated.

E X E C U T I V E S U M M A R Y R E P O R T PAGE 001

PROJECT TITLE : PANAMA HOUSING
PROJECT OBJECTIVE : DETERMINE LEAST COST METHOD OF HOUSING 500 FAM
DISCOUNT RATE : 8.60%
PERIOD OF ANALYSIS: 17 YEARS
START YEAR : 1985
BASE YEAR : 1985

ASSUMPTIONS OF THE ANALYSIS:
For the conventional MCA construction alternative (#4), it is assumed that there will be no payment made by the Republic of Panama upon the transfer of the property in 1999.

Complete beneficial occupancy for all alternatives will occur in 1987.

Delivery schedules are assumed to be 60/40% for MCA units and 50/50% for trailer/relocatable units.

Lease and rental Guarantee units will be located on privately owned land.

Normally, imputed land and insurance costs and real estate taxes are included in an EA with a lease as an alternative. Because of the location of the installation, these were ignored for this analysis.

The discount rate is 8.60%, based on 10 year treasury securities.

ALTERNATIVES CONSIDERED FOR THIS ANALYSIS:
There are five alternatives analyzed to meet the requirement of housing 500 families. These are:

1. Lease housing through the Republic of Panama - the Army would enter into an agreement to lease 500 units from the ROP.

2. Build to lease - 500 housing units would be constructed by a private developer and leased to the Army.

3. Rental guarantee - the Army would guarantee 97% occupancy of 500 rental housing units. Occupants receive BAQ/VHA and pay for rent & utilities.

4. MCA Construction - 500 housing units would be built on-post through conventional MCA construction.

5. Purchase trailers/relocatable units - the Army would provide housing for 500 families on-post in trailers/locatable housing units.

ALTERNATIVES COMPARED ($ in thousands):

ALTERNATIVE NAME	NPV	EUAC
1 ROP LEASE	$89,109	$10,163
2 BUILD TO LEASE	$89,909	$10,254
3 RENT GUARANTEE	$57,173	$6,520
4 MCA CONSTRUCTION	$71,944	$8,205
5 TRAILER	$53,623	$6,115

RESULTS AND RECOMMENDATIONS:
The lowest cost alternative is the trailer/relocatable housing units alternative. It is more than $3.5 Million less expensive than any other.

A sensitivity analysis which allowed the estimated maintenance costs of the trailer/relocatable alternative to increase by as much as 50% was performed. The rental guarantee became the least cost alternative if the maintenance costs increased by 49.7%.

The sensitivity of the results to changes in the discount rate was tested. The analysis is insensitive to +25% change in the 8.60% rate.

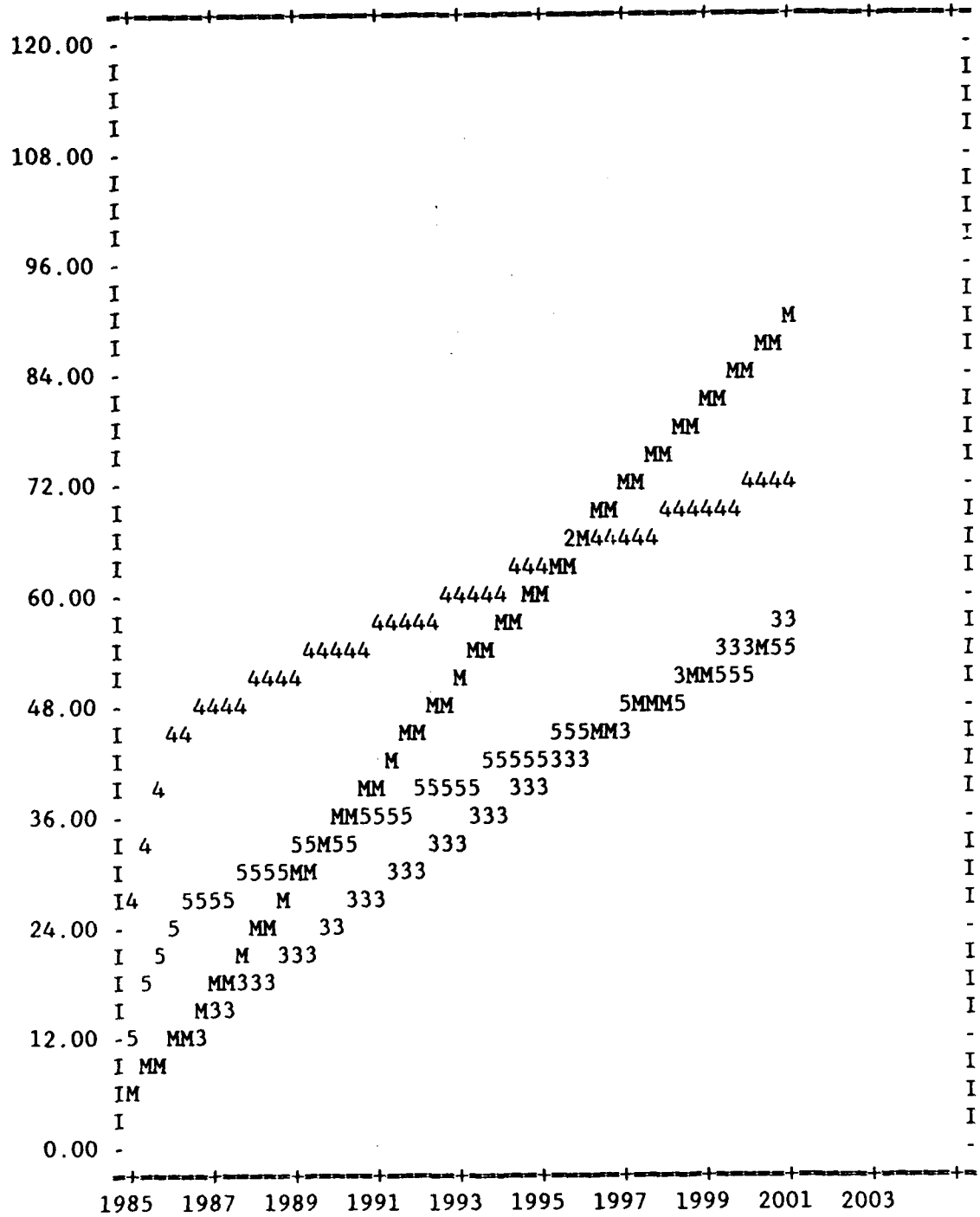
It is recommended that the trailer/relocatable alternative be funded.

ACTION OFFICER: BOB N
ORGANIZATION : USA-CERL

FILENAME: PANAMAJL
13 NOV 1988

E C O N O M I C A N A L Y S I S G R A P H 1

CUMULATIVE NET PRESENT VALUE ($ in millions)



FISCAL YEAR

LEGEND	DESCRIPTION	LEGEND	DESCRIPTION
1	ROP LEASE	5	TRAILER
2	BUILD TO LEASE	M	MERGING DATA
3	RENT GUARANTEE		
4	MCA CONSTRUCTION		

L I F E C Y C L E C O S T R E P O R T PAGE 001

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 1: ROP LEASE

YEAR	LEASE RENT (01)	SERVICES (02)	UTILITIES (03)	MAINTENANCE AND REPAIR (04)	ALLOWANCES (05)
1985	$0	$0	$0	$0	$5,943
1986	$0	$0	$0	$0	$6,240
1987	$4,263	$346	$2,325	$488	$13
1988	$4,562	$363	$2,441	$512	$14
1989	$4,881	$381	$2,563	$538	$14
1990	$5,223	$400	$2,691	$565	$15
1991	$5,589	$420	$2,826	$593	$16
1992	$5,980	$441	$2,967	$623	$17
1993	$6,398	$463	$3,116	$654	$17
1994	$6,846	$486	$3,271	$687	$18
1995	$7,325	$511	$3,435	$721	$19
1996	$7,838	$536	$3,607	$757	$20
1997	$8,387	$563	$3,787	$795	$21
1998	$8,974	$591	$3,976	$835	$22
1999	$9,602	$621	$4,175	$876	$23
2000	$10,274	$652	$4,384	$920	$24
2001	$10,993	$684	$4,603	$966	$26
%NPV	52.74	3.78	25.42	5.33	12.73

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 1: ROP LEASE

YEAR	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1985	$5,943	$5,703	$5,703
1986	$6,240	$5,514	$11,217
1987	$7,435	$6,050	$17,267
1988	$7,892	$5,913	$23,180
1989	$8,377	$5,779	$28,959
1990	$8,894	$5,651	$34,610
1991	$9,444	$5,524	$40,134
1992	$10,028	$5,401	$45,535
1993	$10,648	$5,281	$50,816
1994	$11,308	$5,165	$55,981
1995	$12,011	$5,051	$61,032
1996	$12,758	$4,941	$65,973
1997	$13,553	$4,832	$70,805
1998	$14,398	$4,727	$75,532
1999	$15,297	$4,625	$80,157
2000	$16,254	$4,524	$84,681
2001	$17,272	$4,428	$89,109

EQUIVALENT UNIFORM ANNUAL COST = $10,163 (8.60% DISCOUNT RATE, 17 YEARS)

EXPENSE ITEM 1 USED INFLATION INDEX 1 - MOBILE PROJECTION.
EXPENSE ITEMS 2, 3, 4 AND 5 USED INFLATION INDEX 2 - OSD GENERAL.

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 2: BUILD TO LEASE

YEAR	ALLOWANCES (01)	LEASE RENT (02)	SERVICES (03)	UTILITIES (04)	MAINTENANCE (05)
1985	$5,943	$0	$0	$0	$0
1986	$6,240	$0	$0	$0	$0
1987	$0	$4,761	$54	$2,000	$637
1988	$0	$5,094	$57	$2,100	$669
1989	$0	$5,451	$60	$2,205	$702
1990	$0	$5,832	$63	$2,315	$738
1991	$0	$6,241	$66	$2,431	$774
1992	$0	$6,677	$69	$2,552	$813
1993	$0	$7,145	$73	$2,680	$854
1994	$0	$7,645	$76	$2,814	$897
1995	$0	$8,180	$80	$2,954	$941
1996	$0	$8,753	$84	$3,102	$988
1997	$0	$9,365	$88	$3,257	$1,038
1998	$0	$10,021	$93	$3,420	$1,090
1999	$0	$10,722	$97	$3,591	$1,144
2000	$0	$11,473	$102	$3,771	$1,201
2001	$0	$12,276	$107	$3,959	$1,262
%NPV	12.48	58.37	0.59	21.67	6.90

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 2: BUILD TO LEASE

YEAR	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1985	$5,943	$5,703	$5,703
1986	$6,240	$5,514	$11,217
1987	$7,452	$6,063	$17,280
1988	$7,920	$5,933	$23,213
1989	$8,418	$5,807	$29,020
1990	$8,948	$5,684	$34,704
1991	$9,512	$5,564	$40,268
1992	$10,111	$5,447	$45,715
1993	$10,752	$5,332	$51,047
1994	$11,432	$5,220	$56,267
1995	$12,155	$5,112	$61,379
1996	$12,927	$5,006	$66,385
1997	$13,748	$4,901	$71,286
1998	$14,624	$4,801	$76,087
1999	$15,554	$4,703	$80,790
2000	$16,547	$4,606	$85,396
2001	$17,604	$4,513	$89,909

EQUIVALENT UNIFORM ANNUAL COST = $10,254 (8.60% DISCOUNT RATE, 17 YEARS)

EXPENSE ITEM 2 USED INFLATION INDEX 1 - MOBILE PROJECTION.
EXPENSE ITEMS 1, 3, 4 AND 5 USED INFLATION INDEX 2 - OSD GENERAL.

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 3: RENT GUARANTEE

YEAR	ALLOWANCES (01)	LEASE RENT (02)	SERVICES (03)	TOTAL ANNUAL OUTLAYS	PRESENT VALUE
1985	$5,943	$0	$0	$5,943	$5,703
1986	$6,240	$0	$0	$6,240	$5,514
1987	$0	$4,121	$54	$4,175	$3,397
1988	$0	$4,410	$57	$4,467	$3,347
1989	$0	$4,719	$60	$4,779	$3,296
1990	$0	$5,049	$63	$5,112	$3,247
1991	$0	$5,402	$66	$5,468	$3,199
1992	$0	$5,780	$69	$5,849	$3,150
1993	$0	$6,185	$73	$6,258	$3,104
1994	$0	$6,618	$76	$6,694	$3,057
1995	$0	$7,081	$80	$7,161	$3,012
1996	$0	$7,577	$84	$7,661	$2,967
1997	$0	$8,107	$88	$8,195	$2,922
1998	$0	$8,675	$93	$8,768	$2,878
1999	$0	$9,282	$97	$9,379	$2,835
2000	$0	$9,932	$102	$10,034	$2,793
2001	$0	$10,627	$107	$10,734	$2,752
%NPV	19.62	79.46	0.92		

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 3: RENT GUARANTEE

YEAR	CUMULATIVE NET PRESENT VALUE
1985	$5,703
1986	$11,217
1987	$14,614
1988	$17,961
1989	$21,257
1990	$24,504
1991	$27,703
1992	$30,853
1993	$33,957
1994	$37,014
1995	$40,026
1996	$42,993
1997	$45,915
1998	$48,793
1999	$51,628
2000	$54,421
2001	$57,173

EQUIVALENT UNIFORM ANNUAL COST = $6,520 (8.60% DISCOUNT RATE, 17 YEARS)

EXPENSE ITEM 2 USED INFLATION INDEX 1 - MOBILE PROJECTION.
EXPENSE ITEMS 1 AND 3 USED INFLATION INDEX 2 - OSD GENERAL.

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 4: MCA CONSTRUCTION

YEAR	ALLOWANCES (01)	DESIGN AND CONSTRUCTION (02)	UTILITIES (03)	MAINTENANCE AND REPAIR (04)	EQUIPMENT (05)
1985	$5,943	$22,308	$0	$0	$429
1986	$2,496	$15,913	$1,135	$174	$300
1987	$0	$0	$1,986	$305	$13
1988	$0	$0	$2,085	$320	$14
1989	$0	$0	$2,190	$336	$14
1990	$0	$0	$2,299	$353	$15
1991	$0	$0	$2,414	$371	$16
1992	$0	$0	$2,535	$389	$17
1993	$0	$0	$2,662	$409	$17
1994	$0	$0	$2,795	$429	$18
1995	$0	$0	$2,934	$451	$19
1996	$0	$0	$3,081	$473	$20
1997	$0	$0	$3,235	$497	$21
1998	$0	$0	$3,397	$522	$22
1999	$0	$0	$3,567	$548	$23
2000	$0	$0	$3,745	$575	$24
2001	$0	$0	$3,932	$604	$26
%NPV	10.99	49.30	28.28	4.35	1.12

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 4: MCA CONSTRUCTION

YEAR	SERVICES (06)	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1985	$0	$28,680	$27,521	$27,521
1986	$244	$20,262	$17,905	$45,426
1987	$418	$2,722	$2,215	$47,641
1988	$439	$2,858	$2,141	$49,782
1989	$461	$3,001	$2,071	$51,853
1990	$484	$3,151	$2,001	$53,854
1991	$508	$3,309	$1,935	$55,789
1992	$533	$3,474	$1,871	$57,660
1993	$560	$3,648	$1,810	$59,470
1994	$588	$3,830	$1,749	$61,219
1995	$618	$4,022	$1,692	$62,911
1996	$648	$4,222	$1,635	$64,546
1997	$681	$4,434	$1,581	$66,127
1998	$715	$4,656	$1,528	$67,655
1999	$751	$4,889	$1,478	$69,133
2000	$788	$5,132	$1,429	$70,562
2001	$828	$5,390	$1,382	$71,944
%NPV	5.96			

EQUIVALENT UNIFORM ANNUAL COST = $8,205 (8.60% DISCOUNT RATE, 17 YEARS)

EXPENSE ITEM 2 USED INFLATION INDEX 1 - MOBILE PROJECTION.
EXPENSE ITEMS 1, 3, 4, 5 AND 6 USED INFLATION INDEX 2 - OSD GENERAL.

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 5: TRAILER

YEAR	ALLOWANCES (01)	DESIGN AND CONSTRUCTION (02)	SERVICES (03)	UTILITIES (04)	MAINTENANCE AND REPAIR (05)
1985	$5,943	$6,465	$0	$0	$0
1986	$3,120	$6,918	$203	$865	$291
1987	$0	$0	$427	$1,817	$610
1988	$0	$0	$448	$1,907	$641
1989	$0	$0	$471	$2,003	$673
1990	$0	$0	$494	$2,103	$706
1991	$0	$0	$519	$2,208	$742
1992	$0	$0	$545	$2,318	$779
1993	$0	$0	$572	$2,434	$818
1994	$0	$0	$601	$2,556	$858
1995	$0	$0	$631	$2,684	$901
1996	$0	$0	$662	$2,818	$1,388
1997	$0	$0	$696	$2,959	$1,457
1998	$0	$0	$730	$3,107	$1,530
1999	$0	$0	$767	$3,262	$1,607
2000	$0	$0	$805	$3,425	$1,687
2001	$0	$0	$846	$3,597	$1,772
%NPV	15.78	22.97	8.10	34.43	13.32

PROJECT/PROGRAM COSTS ($ in thousands)

ALTERNATIVE 5: TRAILER

YEAR	TRANSPORT (06)	TOTAL ANNUAL OUTLAYS	PRESENT VALUE	CUMULATIVE NET PRESENT VALUE
1985	$1,537	$13,945	$13,382	$13,382
1986	$1,614	$13,011	$11,496	$24,878
1987	$0	$2,854	$2,321	$27,199
1988	$0	$2,996	$2,245	$29,444
1989	$0	$3,147	$2,171	$31,615
1990	$0	$3,303	$2,099	$33,714
1991	$0	$3,469	$2,030	$35,744
1992	$0	$3,642	$1,962	$37,706
1993	$0	$3,824	$1,896	$39,602
1994	$0	$4,015	$1,833	$41,435
1995	$0	$4,216	$1,773	$43,208
1996	$0	$4,868	$1,885	$45,093
1997	$0	$5,112	$1,823	$46,916
1998	$0	$5,367	$1,762	$48,678
1999	$0	$5,636	$1,704	$50,382
2000	$0	$5,917	$1,648	$52,030
2001	$0	$6,215	$1,593	$53,623
%NPV	5.41			

EQUIVALENT UNIFORM ANNUAL COST = $6,115 (8.60% DISCOUNT RATE, 17 YEARS)

EXPENSE ITEM 2 USED INFLATION INDEX 1 - MOBILE PROJECTION.
EXPENSE ITEMS 1, 3, 4, 5 AND 6 USED INFLATION INDEX 2 - OSD GENERAL.

SOURCE AND DERIVATION OF COSTS AND BENEFITS:
Cost estimation was performed by the estimators in the District Office. Costs were made in 1985 dollars. Maintenance, repair, utilities, equipment and services costs estimates were made by the DEH staff with the assistance of the district office.

Two inflation indices were used. One was developed by the Mobile DO (7%/yr) and the other was published by OSD (5%/yr).

ALTERNATIVE 1 ROP LEASE
Allowances - $5,800,000 for the first two years of the analysis, and $11,500 per year for the remaining fifteen years.
Lease rent - $3,600,000 per year.
Services - $306,000 per year.
Utilities - $2,058,000 per year.
M&R - $432,000 per year.
All were to be specified in the lease. Lease rent was inflated using the DO schedule and all other costs inflated using the OSD schedule.

ALTERNATIVE 2 BUILD TO LEASE
Allowances - $5,800,000 for the first two years.
Lease rent - $4,020,000 per year.
Services - $48,000 per year.
Utilities - $1,770,000 per year.
M&R costs - $564,000 per year.
The lease rent cost was inflated using the DO schedule and all other costs inflated using the OSD schedule.

ALTERNATIVE 3 RENTAL GUARANTEE
Allowances - $5,800,000 for the first two years of the analysis.
Lease cost (reflects BAQ/VHA payments) - $3,480,000.
Services - $48,000 per year.
Lease cost used the DO inflation schedule, all others used the OSD schedule.

ALTERNATIVE 4 MCA CONSTRUCTION
MCA construction cost was developed by use of the Tri-Service cost model.
($71,888 per unit) x 500 units = $35,944,000
Utilities - $1,054,800 the 2nd year of the analysis, $1,758,000/yr thereafte
M&R costs - $162,000 the 2nd year of the analysis, $270,000/yr thereafter.
Service costs reflect garbage collection and entomological services. This cost is based on current annual costs per unit in Panama - $226,800 the 2nd year of the analysis, $370,000 thereafter.
Allowances - $5,800,000 the 1st year of the analysis, $2,320,000 the 2nd yr.
Equipment costs reflect

washer/dryer	$422
range	$722
refrigerator	$250
	$1,394 per unit

$1394 X 500 units = $697,000
Maintenance and repair of equipment was estimated at $11,500 per year.
Construction cost used the DO inflation schedule, all others the OSD one.

SOURCE AND DERIVATION OF COSTS AND BENEFITS (cont.):

ALTERNATIVE 5 TRAILERS/RELOCATABLE HOUSING UNITS
Design and construction, including furnishings ($25,000 each) - $12,500,000.
Transportation costs (shipping) - $6,000 per unit or $1,500,000 for 2 years.
Allowances - $5,800,000 in the 1st year and $2,900,000 in the second year.
Utilities - $804,000 for the second year of the analysis, $1,608,000 for the next 15 years.
Services - $189,000 in the 2nd year of the analysis and $378,000 thereafter.
M&R - $270,000 for the second year of the analysis, $540,000 for the next nine years and $792,000 for the remaining six years.
Design and construction costs used the DO inflation schedule, all others the OSD schedule.

R A N K I N G S E N S I T I V I T Y A N A L Y S I S PAGE 001
($ in thousands)

SENSITIVITY ANALYSIS NUMBER 01
TITLE ..... Increase of M&R costs for alt
5 vs next lowest cost alt #3
ALLOWABLE CHANGE ..... 50.00 PERCENT

THIS SENSITIVITY ANALYSIS CHECKS FOR ALTERNATIVE 3 TO BE RANKED
FIRST AS A RESULT OF CHANGES IN THE EXPENSE ITEM(S) LISTED BELOW:

ALTERNATIVE	EXPENSE ITEM(S)
3	** NOTHING CHANGED **
5	5

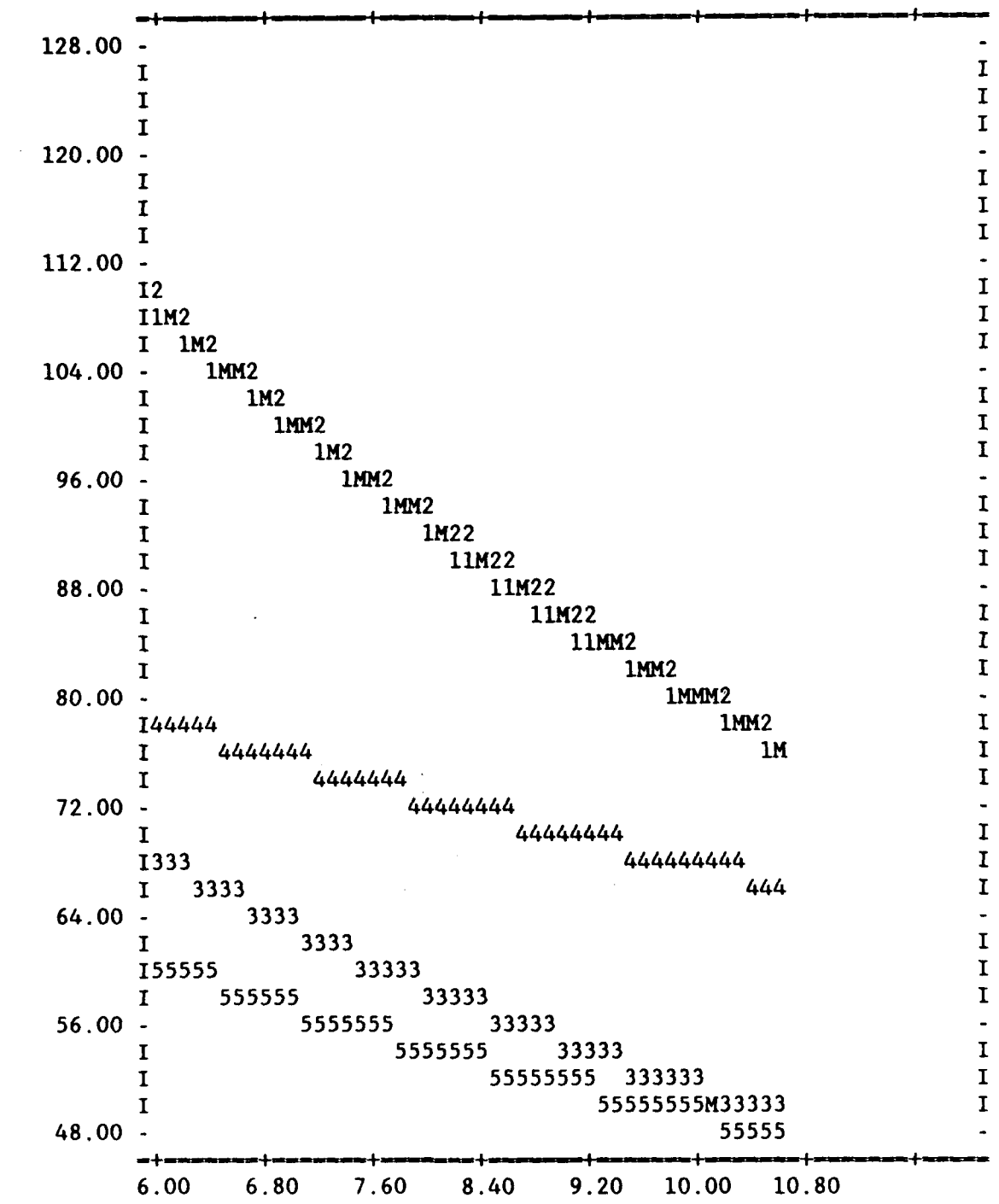
THE SELECTED EXPENSE ITEMS ARE ALLOWED TO VARY FROM A VALUE OF 100%
LESS THAN THEIR INPUT VALUE TO 50.00% MORE THAN THEIR INPUT VALUE.

ALTERNATIVE	NET PRESENT VALUE
5	$53,623
3	$57,173

FOR ALTERNATIVE 3 TO BE LEAST COST, INCREASE COSTS BY 49.69% OR MORE.

D I S C O U N T R A T E S E N S I T I V I T Y A N A L Y S I S PAGE 001

Graph of Net Present Value ($ in millions) vs. Discount Rate



LEGEND	DESCRIPTION	LEGEND	DESCRIPTION
1	ROP LEASE	5	TRAILER
2	BUILD TO LEASE	M	MERGING DATA
3	RENT GUARANTEE		
4	MCA CONSTRUCTION		

Summary of Alternative Rankings by Discount Rate

Discount Rate: 8.60 Lower Limit: 6.00 Upper Limit: 10.60

Discount Rate (%)	Alternative Ranking					Discount Rate (%)	Alternative Ranking				
6.00	5	3	4	1	2	8.40	5	3	4	1	2
6.10	5	3	4	1	2	8.50	5	3	4	1	2
6.20	5	3	4	1	2	8.60	5	3	4	1	2
6.30	5	3	4	1	2	8.70	5	3	4	1	2
6.40	5	3	4	1	2	8.80	5	3	4	1	2
6.50	5	3	4	1	2	8.90	5	3	4	1	2
6.60	5	3	4	1	2	9.00	5	3	4	1	2
6.70	5	3	4	1	2	9.10	5	3	4	1	2
6.80	5	3	4	1	2	9.20	5	3	4	1	2
6.90	5	3	4	1	2	9.30	5	3	4	1	2
7.00	5	3	4	1	2	9.40	5	3	4	1	2
7.10	5	3	4	1	2	9.50	5	3	4	1	2
7.20	5	3	4	1	2	9.60	5	3	4	1	2
7.30	5	3	4	1	2	9.70	5	3	4	1	2
7.40	5	3	4	1	2	9.80	5	3	4	1	2
7.50	5	3	4	1	2	9.90	5	3	4	1	2
7.60	5	3	4	1	2	10.00	5	3	4	1	2
7.70	5	3	4	1	2	10.10	5	3	4	1	2
7.80	5	3	4	1	2	10.20	5	3	4	1	2
7.90	5	3	4	1	2	10.30	5	3	4	1	2
8.00	5	3	4	1	2	10.40	5	3	4	1	2
8.10	5	3	4	1	2	10.50	5	3	4	1	2
8.20	5	3	4	1	2	10.60	5	3	4	1	2
8.30	5	3	4	1	2						

* indicates a change in the alternative ranking occurred.

Table of Net Present Value ($ in thousands) for each Discount Rate

Discount Rate = 6.00%			Discount Rate = 6.10%			Discount Rate = 6.20%		
Alt	-	NPV	Alt	-	NPV	Alt	-	NPV
5	-	$61,447	5	-	$61,102	5	-	$60,762
3	-	$69,266	3	-	$68,730	3	-	$68,205
4	-	$79,482	4	-	$79,151	4	-	$78,828
1	-	$109,097	1	-	$108,212	1	-	$107,338
2	-	$110,150	2	-	$109,258	2	-	$108,373

Discount Rate = 6.30%			Discount Rate = 6.40%			Discount Rate = 6.50%		
Alt	-	NPV	Alt	-	NPV	Alt	-	NPV
5	-	$60,426	5	-	$60,097	5	-	$59,767
3	-	$67,682	3	-	$67,163	3	-	$66,655
4	-	$78,506	4	-	$78,186	4	-	$77,872
1	-	$106,481	1	-	$105,621	1	-	$104,777
2	-	$107,500	2	-	$106,635	2	-	$105,778

Discount Rate = 6.60%			Discount Rate = 6.70%			Discount Rate = 6.80%		
Alt	-	NPV	Alt	-	NPV	Alt	-	NPV
5	-	$59,442	5	-	$59,121	5	-	$58,800
3	-	$66,150	3	-	$65,650	3	-	$65,156
4	-	$77,557	4	-	$77,251	4	-	$76,950
1	-	$103,948	1	-	$103,121	1	-	$102,300
2	-	$104,932	2	-	$104,099	2	-	$103,271

Discount Rate = 6.90%			Discount Rate = 7.00%			Discount Rate = 7.10%		
Alt	-	NPV	Alt	-	NPV	Alt	-	NPV
5	-	$58,485	5	-	$58,175	5	-	$57,865
3	-	$64,668	3	-	$64,188	3	-	$63,711
4	-	$76,643	4	-	$76,344	4	-	$76,052
1	-	$101,500	1	-	$100,699	1	-	$99,919
2	-	$102,456	2	-	$101,650	2	-	$100,853

Table of Net Present Value ($ in thousands) for each Discount Rate

Discount Rate = 7.20%			Discount Rate = 7.30%			Discount Rate = 7.40%		
Alt	-	NPV	Alt	-	NPV	Alt	-	NPV
5	-	$57,561	5	-	$57,260	5	-	$56,961
3	-	$63,240	3	-	$62,776	3	-	$62,313
4	-	$75,756	4	-	$75,466	4	-	$75,180
1	-	$99,137	1	-	$98,367	1	-	$97,606
2	-	$100,065	2	-	$99,288	2	-	$98,512

Discount Rate = 7.50%			Discount Rate = 7.60%			Discount Rate = 7.70%		
Alt	-	NPV	Alt	-	NPV	Alt	-	NPV
5	-	$56,663	5	-	$56,379	5	-	$56,088
3	-	$61,857	3	-	$61,409	3	-	$60,965
4	-	$74,895	4	-	$74,613	4	-	$74,337
1	-	$96,853	1	-	$96,111	1	-	$95,374
2	-	$97,749	2	-	$96,997	2	-	$96,252

Discount Rate = 7.80%			Discount Rate = 7.90%			Discount Rate = 8.00%		
Alt	-	NPV	Alt	-	NPV	Alt	-	NPV
5	-	$55,804	5	-	$55,519	5	-	$55,239
3	-	$60,522	3	-	$60,086	3	-	$59,658
4	-	$74,056	4	-	$73,783	4	-	$73,512
1	-	$94,642	1	-	$93,929	1	-	$93,217
2	-	$95,513	2	-	$94,786	2	-	$94,070

Discount Rate = 8.10%			Discount Rate = 8.20%			Discount Rate = 8.30%		
Alt	-	NPV	Alt	-	NPV	Alt	-	NPV
5	-	$54,966	5	-	$54,690	5	-	$54,419
3	-	$59,230	3	-	$58,811	3	-	$58,397
4	-	$73,245	4	-	$72,979	4	-	$72,715
1	-	$92,510	1	-	$91,813	1	-	$91,128
2	-	$93,355	2	-	$92,647	2	-	$91,955

Table of Net Present Value ($ in thousands) for each Discount Rate

Discount Rate = 8.40%		Discount Rate = 8.50%		Discount Rate = 8.60%	
Alt	NPV	Alt	NPV	Alt	NPV
5	$54,148	5	$53,884	5	$53,623
3	$57,981	3	$57,579	3	$57,173
4	$72,454	4	$72,196	4	$71,944
1	$90,445	1	$89,774	1	$89,109
2	$91,260	2	$90,582	2	$89,909

Discount Rate = 8.70%		Discount Rate = 8.80%		Discount Rate = 8.90%	
Alt	NPV	Alt	NPV	Alt	NPV
5	$53,358	5	$53,104	5	$52,852
3	$56,776	3	$56,383	3	$55,991
4	$71,687	4	$71,440	4	$71,188
1	$88,450	1	$87,797	1	$87,157
2	$89,245	2	$88,586	2	$87,931

Discount Rate = 9.00%		Discount Rate = 9.10%		Discount Rate = 9.20%	
Alt	NPV	Alt	NPV	Alt	NPV
5	$52,600	5	$52,349	5	$52,104
3	$55,609	3	$55,227	3	$54,846
4	$70,942	4	$70,699	4	$70,462
1	$86,520	1	$85,895	1	$85,266
2	$87,286	2	$86,650	2	$86,018

Discount Rate = 9.30%		Discount Rate = 9.40%		Discount Rate = 9.50%	
Alt	NPV	Alt	NPV	Alt	NPV
5	$51,857	5	$51,617	5	$51,376
3	$54,476	3	$54,105	3	$53,743
4	$70,226	4	$69,980	4	$69,751
1	$84,651	1	$84,039	1	$83,439
2	$85,394	2	$84,777	2	$84,164

Table of Net Present Value ($ in thousands) for each Discount Rate

Discount Rate = 9.60%		
Alt	-	NPV
5	-	$51,140
3	-	$53,385
4	-	$69,516
1	-	$82,838
2	-	$83,562

Discount Rate = 9.70%		
Alt	-	NPV
5	-	$50,906
3	-	$53,025
4	-	$69,291
1	-	$82,251
2	-	$82,965

Discount Rate = 9.80%		
Alt	-	NPV
5	-	$50,675
3	-	$52,670
4	-	$69,060
1	-	$81,665
2	-	$82,375

Discount Rate = 9.90%		
Alt	-	NPV
5	-	$50,443
3	-	$52,320
4	-	$68,835
1	-	$81,087
2	-	$81,792

Discount Rate = 10.00%		
Alt	-	NPV
5	-	$50,216
3	-	$51,976
4	-	$68,612
1	-	$80,517
2	-	$81,212

Discount Rate = 10.10%		
Alt	-	NPV
5	-	$49,988
3	-	$51,634
4	-	$68,388
1	-	$79,952
2	-	$80,642

Discount Rate = 10.20%		
Alt	-	NPV
5	-	$49,768
3	-	$51,298
4	-	$68,174
1	-	$79,392
2	-	$80,075

Discount Rate = 10.30%		
Alt	-	NPV
5	-	$49,545
3	-	$50,960
4	-	$67,953
1	-	$78,843
2	-	$79,510

Discount Rate = 10.40%		
Alt	-	NPV
5	-	$49,327
3	-	$50,627
4	-	$67,739
1	-	$78,295
2	-	$78,953

Discount Rate = 10.50%		
Alt	-	NPV
5	-	$49,107
3	-	$50,300
4	-	$67,525
1	-	$77,748
2	-	$78,409

Discount Rate = 10.60%		
Alt	-	NPV
5	-	$48,897
3	-	$49,978
4	-	$67,315
1	-	$77,210
2	-	$77,865

GLOSSARY

Section I

Abbreviations

ABCR
annual benefit/cost ratio

ABOM
annual benefit/output measure

ADP
automated data processing

AR
Army Regulation

ASA(I&L)
Assistant Secretary of the Army for Installations and Logistics

BAQ
basic allowance for quarters

BCR
benefit/cost ratio

BOD
beneficial occupancy date

BOQ
bachelor officers quarters

CFF
Commercially Financed Facilities

CONUS
Continental United States

DA
Department of the Army

DEH
Directorate of Engineering and Housing

DIO
Directorate of Industrial Operations

DOD
Department of Defense

DPP
discounted payback period

EA
economic analysis

E&C
Directorate of Engineering and Construction

ECONPACK
Economic Analysis Computer Program

EPIR
efficiency/productivity increase ratio

EUAC
equivalent uniform annual cost

HHG
household goods

HQDA
Headquarters, Department of the Army

MCA
Military Construction, Army
(Also called MILCON--Military Construction)

MILCON
Military Construction

MPA
Military Personnel, Army

NPV
net present value

O&M
operation and maintenance

OCONUS
outside Continental United States

OMB
Office of Management and Budget

OPM
Office of Personnel Management

OSD
Office of the Secretary of Defense

PAX
Programming, Administration, and Execution System

RIF
reduction in force

RFP
request for proposal

SIR
savings/investment ratio

SOFA
Status of Forces Agreement

TDY
temporary duty

VHA
variable housing allowance

USACE
U.S. Army Corps of Engineers

Section II

Terms

Acquisition cost
The amount paid to obtain an asset.

Alternative
A course of action, means, or methods by which an objective can be achieved.

Alternative ranking
The end result of an economic analysis; the rating of options from lowest to highest in terms of a dollar value or another indicator.

Analysis
A systematic approach to problem-solving. Complex problems are made simpler by separating them into more understandable elements. Involves identification of purposes and facts, statement of assumptions, and derivation of conclusions. Analyses normally use quantitative methods and are done to support decision-making processes.

Appropriation
The most common form of budget authority. Allows Federal agencies to incur obligations and make expenditures for specified purposes and in specified amounts as authorized by the U.S. Congress.

Assets
Real and personal property and other items of monetary value.

Assumption
An explicit statement describing present or future circumstances that may affect the outcome of an analysis.

Base year
The reference year for all present value calculations (costs are converted to present value amounts as of the beginning of the base year).

Benefit
Outputs or effectiveness expected to be received or achieved over time as a result of implementing an alternative. These can be quantifiable in terms of dollar value or some other measure of productivity, or nonquantifiable as in the case of intangible effects such as increased morale.

Benefit/cost ratio
An economic indicat of efficiency defined as the ratio of the value of benefits to costs. When benefits are expressed in dollar terms, both the benefit and cost streams are discounted to reflect the present value of future costs and benefits.

Budget year
Precedes the program year in which funds are made available for construction and follows the design year. The year in which the Army defends the MILCON Program before OSD, OMB, and Congress, and the year final design is to be substantially completed.

Build-to-lease
A program for providing Government facilities through private sector development. The Government contracts with a private developer to have facilities built, with a guarantee that the Government will lease the facilities for a period of time.

Capital
Assets of a permanent character having continuing value. Examples are land, buildings, and other facilities, including equipment.

Commercially Financed Facilities (CFF)
Facilities financed by the private sector as an alternative funding method for DOD to procure certain types of service facilities. Different types of construction programs (MILCON, AFH, Energy) derive Authority to pursue CFF from separate laws.

Compound interest
Interest which is computed on both the original principal and its accrued interest.

Constant year dollars
Estimate in which costs reflect the level of prices of a base year. Cost estimates expressed in constant dollars imply the purchasing power of the dollar remains unchanged over the analysis period.

Cost
A resource input to a project, program, or activity expressed in dollar terms.

Cost analysis
Determines the magnitude, timing and uncertainties of prices for alternatives. A critical part of economic analysis, it translates resource requirements into estimated dollar costs.

Cost/benefit analysis
Technique for assessing the range of costs and benefits associated with a given alternative, usually to determine feasibility. Costs are normally in monetary terms, but benefits need not be.

Cost element
Basic unit of cost, such as labor or material. Related basic units are accumulated to form the total cost of each cost kind. (See cost kind.)

Cost-estimating relationship
A numerical function expressing the relationship between a characteristic, resource, or activity and a particular cost associated with it. The function may be a simple percentage or a complex equation. For example, the annual cost of maintenance for a dwelling unit may be related to the age of the unit.

Cost kind
A group of similar cost elements.

Cumulative net present value
The total of the discounted annual cost for the year in question and all preceding years of the project.

Current dollars
Convention used to show purchasing power in the year spent. Prior costs stated in current dollars are the actual amounts paid out. Future costs stated in current dollars are the actual amounts expected to be paid, including amounts caused by future price changes (inflation).

Data
Numerical information of any kind.

Depreciation
A reduction in the value of an asset estimated to have accrued during an accounting period due to age, wear, usage, obsolescence, or the effects of natural elements such as decay and corrosion.

Design year
The year immediately before the budget year and immediately after the guidance year. It is the year design begins in a construction program.

Differential inflation
The difference in inflation between the rate for the overall economy and the rate for a particular cost which is either greater or less than the general inflation rate.

Disbenefit
An undesirable result; an offset to benefits.

Discount factor
Multiplier calculated using the present value formula and a discount rate. Used to convert a future cost into its present value.

Discount rate
Interest rate used to relate present and future dollars. Expressed as a percentage and used to reduce the value of future dollars in relation to present dollars to account for the time value of money.

Discounting
Technique for converting various cash flows occurring over a period of time to equivalent amounts at a common point in time, considering the time value of money, to allow valid comparisons.

Discounting convention
Method of discounting costs, either at beginning-of-year, midyear, or end-of-year.

Discounted payback period (DPP)
Time required for the accumulated present value of savings of a proposed alternative to equal the total present value of its investment costs.

Economic analysis (EA)
A systematic method for quantifying the costs and benefits of alternative solutions for achieving an objective in order to find the most efficient (economical) solution. Structured method to identify, analyze, and compare costs and benefits of the alternatives.

Economic life
Period of time over which the benefits from an alternative are expected to accrue. The economic life of an alternative starts in the year it begins producing benefits. The economic life is not necessarily the same as physical life or technological life.

Engineering estimate
Prediction of costs based on detailed measurements or experiments and specialized knowledge and judgment. Also called "engineering method of cost estimating."

Equivalent uniform annual cost (EUAC)
The amount of money which, if paid in equal annual installments over the life of a project, would pay for the project. That is, the discounted value of this hypothetical uniform cost stream is equal to the actual estimated present value of project costs. The alternative with the lowest uniform annual equivalent amount is the least costly alternative.

Externalities
Benefits and costs that affect parties other than ones directly involved. Also called "spillovers." An external economy is a benefit received by one from an economic activity of another for which the beneficiary cannot be charged. An external diseconomy is a cost borne or damage suffered consequent to the economic activities of others for which the injured is not compensated. For example, a city downstream benefits from, but does not pay for, a water pollution control program instituted by a military base upstream.

Guidance year
The year preceding the design year. It begins with the Army guidance documents providing general instructions and the present policies of HQDA. Included are military construction programs and program dollar guidance for each Major Command's MILCON program.

Historical cost
Price based on actual monetary (or equivalent) outlay, determined after the fact. Any method of cost determination can be used, but the sources of costs must be documented in the source derivation part of the EA report.

Imputed cost
Costs that do not involve an actual expenditure of funds. They are not actually incurred but must be included in certain types of EAs.

Index
Statistical device for measuring changes in groups of data; serves as a yardstick of comparative measure, expressed as an index number.

Inflation
A persistent rise in the general level of prices over time which results in a decline in the purchasing power of money. Measured by changes in price indices relative to some base year.

Inherited asset
An existing asset that will be used in an alternative. If the asset could be used for some other purpose or sold, its value is included as a cost in the alternative. If it has no use or value except in the alternative, no cost is included.

Interest
A price (or rent) charged for the use of money.

Investment costs
Costs associated with acquisition of real property, nonrecurring services, nonrecurring operation, and maintenance (start-up) costs. These are usually one-time costs, although they may be spread over more than 1 year (such as construction costs).

Lead time
The period between initial funding or decision and commencement of the economic life.

Least-cost alternative
The option producing, at less cost, the same or greater quantity of a given output than another alternative.

Life-cycle cost
The total price of an item over its life cycle. Includes initial investment, maintenance and repair, operations, utilities and, where applicable, disposal.

Maintenance and repair cost
Costs incurred to keep buildings and equipment in normal operating condition.

Net present value (NPV)
The cumulative discounted amount that also includes the discounted value of the residual amount.

Nonrecurring cost
Cost that occurs on a one-time basis as compared with annually recurring costs.

Objective
The result to be achieved by the project being studied. It must be stated in unbiased terms.

Operations costs
Utilities, custodial, and other routine costs incurred in operating a facility, not including maintenance and repair.

Optimization
A determination of the best mix of inputs to achieve an objective.

Opportunity cost
Amount of money associated with expending capital resources instead of investing them. If funds are expended, the potential that might be gained from investing them is lost. In the private sector, opportunity costs are equivalent to interest rates adjusted for inflation.

Output
Products, functions, tasks, services, or capabilities that an organization exists to produce, accomplish, attain, or maintain.

Period of analysis
Time span over which an EA takes place; that is, the time over which alternatives are compared.

Physical life
Estimated number of years that a piece of equipment or building can physically be used in accomplishing the function for which it was procured or constructed.

Present value (PV)
Monetary expenditure (or savings) multiplied by the discount factor. The resulting figure represents the worth of the future amount in base year dollars.

Present worth
See present value.

Price
Dollar amount for which a good or service is bought or sold.

Primary analysis
An economic analysis performed when the objective is to change the status quo (present method of operation) in order to achieve a financial savings to the Government.

Program year
The year funds are made available for construction. The first year of the execution phase for each military construction program. It follows the budget year and is the current fiscal year.

Project
A major mission-oriented endeavor that fulfills statutory or executive requirements, and that is defined in terms of the principal action required to achieve a significant objective.

Quantification
Measurement in terms of price of the inputs, outputs, or benefits of a program.

Range
The difference between the smallest and largest quantities in a statistical series arrayed according to size.

Real interest rate
Interest rate with inflation removed, which is used to determine the real rate of return on investmsnt. For an EA, real interest rate is calculated by subtracting current rates of inflation from current interest rates for long-term U.S. Treasury securities.

Real property
Land, utility plants, distribution systems, buildings, structures and their improvements.

Recurring costs
Expenses for personnel, material consumed, operating overhead, support services, maintenance and other items that are charged annually or repetitively in the execution of a given program or work effort.

Refurbishment costs
The cost of renovation, rehabilitation, or similar items under the status quo method of operation which is avoided by the use of an alternative in a primary analysis.

Regression analysis
Evaluation for determining the relationship between two or more variables. Determines the change in a dependent variable caused by changes in one or more independent variables. The relationship may be linear (straight line) or curvilinear.

Rent
Cost incurred for the use of another entity's tangible assets (land, buildings, equipment, etc.).

Replaced asset
An asset substituted with an alternative. It is made available for other use by the Army or is advertised for sale. Its value is subtracted from the NPV of the alternative.

Residual value
The remaining monetary value, if any, of an alternative at a specified point in time.

Resources
Facilities, personnel, equipment, supplies and other items required for an alternative. Once resources are determined, their value in dollars can then be estimated.

Salvage value
The remaining monetary worth, if any, of an alternative at the end of the project life. The value may be negative (it may cost money to remove the item).

Savings
Reduction in costs achieved without reduction in performance. Always computed with respect to the existing course of action or status quo in an economic analysis.

Savings-to-investment ratio (SIR)
Ratio of discounted future cost savings (or avoidance) to the discounted investment cost necessary to effect those savings. An SIR of 1 indicates that the present value of savings is equal to the present value of investment.

Secondary analysis
An economic analysis performed when there is a new requirement to be met or the existing facility is not adequate.

Sensitivity analysis
An examination of how the EA results may change with respect to changes in the costs or timing of costs in an alternative(s). As a minimum, the effect of changes in high-cost elements and questionable assumptions will be studied.

Start year
The first year in which costs are incurred--often the first year of the analysis period.

Sunk cost
Unrecoverable past costs incurred before the analysis. Has no significance to the analysis and is not included.

Technological life
The number of years a facility or piece of equipment will be used before it becomes obsolete due to changes in technology.

Terminal value
Same as salvage value or residual value at the end of the project.

Time value of money
The concept that use of money costs money; a dollar today is worth more than a dollar tomorrow because of the interest costs.

Total annual outlays
The sum of all costs for a given year.

Uncertainty
The state of knowledge about outcomes in a decision which is such that it is not possible to assign probabilities in advance. Doubt or ignorance about the magnitude of cost/benefits or their timing. A technique for assessing the effect of uncertainty on EA results is the sensitivity analysis.

Uniform annual cost
See equivalent uniform annual cost.

Value
The desirability, utility, or importance of an item. The worth of an item in money. Often represented by price. In economic analysis the value of costs and benefits is given in dollars. The value of a good or service is what a consumer is willing to give up to have it.

Wash cost
A cost that is identical for all alternatives. Omitted from an EA because it cannot alter the decision. It would increase the net present value of all alternatives by the same amount during the same time periods.

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